ANNUAL

METEOROLOGICAL REVIEW

OF THE

STATE OF CALIFORNIA,

For the Year 1890,

BY THE

Meteorological Department of the State Agricultural Society.

COMPILED BY

SERGEANT JAMES A. BARWICK,
Observer Signal Corps, U. S. Army, and Meteorologist to the
State Board of Agriculture.

SACRAMENTO:
STATE OFFICE, : : : : : A. J. JOHNSTON, SUPT. STATE PRINTING.
1891.

U. S. SIGNAL SERVICE STATION

And Headquarters of the Meteorological Department of the State Agricultural Society,
Sacramento, California.

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Collated and compiled by SERGEANT JAMES A. BARWICK, Observer Signal Corps, and Meteorologist to the State Board of Agriculture.

SACRAMENTO, CAL., April 10, 1891.

EDWIN F. SMITH, *Secretary State Agricultural Society:*

SIR: I have the honor to submit this my seventh annual meteorological review of this State, or as much of it as I could obtain data therefor. In this year, 1890, there was started by myself, through instructions from the Chief Signal Officer, a weekly weather crop bulletin. It gave such great satisfaction to all concerned that your honorable Board has agreed to assist in its preparation during the growing and harvesting season of 1891.

Very respectfully, your obedient servant,

SERGEANT JAMES A. BARWICK,
Observer Signal Corps, and Meteorologist to State Agricultural Society.

GENERAL WEATHER REVIEW.

ANNUAL WEATHER SUMMARY IN SACRAMENTO, FROM 1878 TO 1890.

Sacramento City is geographically situated in latitude north 38° 35′; longitude west from Greenwich, 121° 30′; elevation above sea level, 35 feet; elevation of the zero point of the barometer cistern above sea level, 64 feet.

The accompanying table gives the average barometer; the highest, lowest, and range of barometer for each year; average temperature; highest, lowest, and range of temperature; greatest and least monthly range of temperature; average maximum, minimum, and range of temperature; average relative humidity and dew point; yearly precipitation; prevailing direction of wind; maximum velocity of wind, and direction at the time of maximum velocity; number of clear, fair, and cloudy days, and number of days each year that rain fell; number of earthquakes, snowstorms, and electric storms; number of solar and lunar halos; light and killing frosts; number of days the maximum temperature was above 90°, and total number of days the minimum temperature was below 32°:

Weather Review for:	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
Average barometer	29.95	30.00	30.03	30.03	30.03	30.03	29.99	29.98	29.99	29.98	29.97	29.97	30.01
Highest barometer	30.51	30.68	30.49	30.46	30.52	30.74	30.58	30.43	30.50	30.46	30.62	30.37	30.47
Lowest barometer	29.46	29.38	29.48	29.61	29.71	29.62	29.42	29.46	29.32	29.45	29.49	29.41	29.43
Range of barometer	1.05	1.30	1.01	0.85	0.81	1.12	1.16	0.97	1.19	1.01	1.13	0.96	1.04
Average temperature	61.3	60.3	57.2	59.2	58.5	58.8	58.8	61.2	58.8	59.9	60.6	60.9	59.4
Highest temperature	100.5	103.0	98.0	98.6	99.8	103.5	100.0	105.0	105.0	100.0	107.5	104.0	102.0
Lowest temperature	23.5	25.0	25.0	31.9	27.0	22.0	21.0	34.2	27.5	28.0	19.0	31.0	29.0
Range of temperature	77.0	78.0	73.0	66.7	72.8	81.5	79.0	70.8	77.5	72.0	88.5	73.0	73.0
Greatest range of temperature	50.0	49.0	49.0	46.7	55.2	55.8	46.0	58.0	52.8	58.7	56.5	54.0	50.0
Least range of temperature	21.0	33.7	25.0	27.0	31.6	35.7	30.0	27.0	33.2	35.2	27.0	27.0	28.0
Average maximum temperature	81.5	83.7	80.0	81.6	82.0	84.3	70.0	73.2	71.5	72.9	73.3	72.5	70.3
Average minimum temperature	41.2	41.2	39.9	42.1	40.1	39.8	49.7	51.8	49.1	47.7	49.4	49.3	48.6
Mean maximum and minimum temp'ture	61.4	62.4	59.9	61.8	61.0	62.0	59.8	62.5	60.3	60.3	61.4	60.9	59.4
Average range of temperature	40.3	42.5	40.1	39.5	41.9	44.5	38.8	40.7	42.6	46.2	45.8	23.2	21.7
Average humidity	62.2	65.7	64.6	66.7	66.0	69.0	70.7	67.8	70.1	63.7	67.1	69.8	68.0
Average dew point	----	----	----	----	45.7	47.3	48.5	48.8	47.8	46.0	47.6	48.2	46.0
Prevailing direction of wind	S.	S.	S.	S.	S.	S.	S.	S.	S.E.	N.W.	S.E.	S.E.	S.E.
Total precipitation	23.45	22.37	31.99	20.71	18.04	13.48	34.92	20.72	18.17	13.43	18.46	27.48	20.95
Velocity of wind	52,830	52,214	62,497	57,846	58,874	52,637	62,611	62,405	56,036	61,322	56,964	58,794	59,616
Maximum velocity of wind	40	39	40	32	36	36	36	36	44	40	48	42	42
Direction of maximum velocity	N.	S.	S.E.	S.E.	S.E.	N.W.	N.W.	S.E.	S.E.	S.E.	S.E.	S.E.	S.E.
Clear days	234	288	237	251	249	263	239	227	262	267	238	218	237
Fair days	75	99	59	69	76	76	68	88	76	74	75	91	59
Cloudy days	56	58	70	45	40	26	59	50	27	24	52	57	69
Foggy days	0	4	5	8	1	11	0	0	4	0	0	0	11
Days of precipitation	66	79	70	67	70	54	76	62	57	56	63	77	55
Earthquakes	2	0	0	1	0	0	0	2	1	1	2	3	0
Snow storms	0	1	1	0	3	2	0	0	0	0	3	0	0
Electric storms	4	4	3	4	4	2	2	6	3	2	3	7	2
Solar halos	1	3	6	2	5	8	9	4	8	8	13	3	3
Lunar halos	0	2	4	2	3	0	9	1	2	0	1	3	2
Light frosts	18	17	14	34	69	33	31	24	30	18	6	18	19
Killing frosts	22	27	32	4	12	40	22	0	10	26	14	14	10
Days temperature was above 90°	35	48	16	18	43	45	22	49	45	48	58	51	28
Days temperature was below 32°	15	14	17	1	5	27	13	0	4	9	12	7	5

MONTHLY SUMMARY AT SACRAMENTO, FOR 1890.

January.—Mean temperature, 43°; 3° cooler than the normal temperature. Highest and lowest temperature, 58° on the 30th, and 29° on the 8th. Rainfall, 6.62 inches, which is 2.86 inches above the normal precipitation obtained from a record of forty-one years. There were 13 clear, 7 fair, and 11 cloudy days, with 17 days on which an appreciable amount of rainfall was measured. There were 9 killing and 2 light frosts. Highest wind velocity, 42 miles, from the southeast, on the 15th.

February.—Mean temperature, 47°; 4° cooler than the normal average temperature. Highest and lowest, 67° on the 3d, and 32° on the 22d. Total rainfall, 4.06 inches; 1.26 inches in excess of the normal precipitation. There were 10 clear, 9 fair, and 9 cloudy days, with 9 days on which an appreciable amount was measured. One frost was all that was seen, and that was a killing one. Maximum wind velocity and direction, 36 miles, from the northwest, on the 13th.

March.—Mean temperature, 53°; 3° cooler than the normal average. Highest and lowest temperature, 69° on the 15th, and 36° on the 10th. Total rainfall, 3 inches; .05 of an inch in excess of the normal precipitation. There were 12 clear, 6 fair, and 13 cloudy days, with 14 days that rain fell to an appreciable amount. Two frosts, one light and one killing. Highest wind velocity and direction, 36 miles, from the southwest, on the 8th.

April.—Mean temperature, 59°; being 1° warmer than the normal average. Highest and lowest temperature, 80° on the 27th, and 44° on the 4th and 13th. Total rainfall, 1.33 inches; .51 of an inch less than the normal precipitation. There were 18 clear, 10 fair, and 2 cloudy days, with four days on which rain fell sufficient to measure. Highest wind velocity and direction, 33 miles, from the northwest, on the 8th.

May.—Mean temperature, 65°; being the same as the normal average. Highest and lowest temperature, 92° on the 24th, and 46° on the 1st. Total rainfall, 1.80 inches; 1.12 inches in excess of the normal precipitation. Highest wind velocity and direction, 28 miles, from the north, on the 13th.

June.—Mean temperature, 68°; 1° less than the normal average. Highest and lowest temperature, 94° on the 14th, and 44° on the 1st. Total rainfall, nothing, which is .12 of an inch less than the normal precipitation. There were 28 clear, and 2 fair days. Highest wind velocity and direction, 27 miles, from the northwest, on the 25th.

July.—Mean temperature, 74°; 1° warmer than the normal average. Highest and lowest temperature, 102° on the 25th and 26th, and 52° on the 9th. Total rainfall, none; being .04 of an inch less than the normal precipitation. There were 30 clear, and 1 fair day. Highest wind velocity and direction, 24 miles, from the southwest, on the 7th.

August.—Mean temperature, 73°; 1° less than the normal average. Highest and lowest temperature, 96° on the 5th, and 51° on the 19th. Total rainfall, a trace; being .003 of an inch less than the normal precipitation. There were 29 clear, and 2 fair days. Highest wind velocity and direction, 24 miles, from the southwest, on the 17th.

September.—Mean temperature, 70°; being the same as the normal. Highest and lowest temperature, 94° on the 14th, and 50° on the 10th. Total rainfall, .80 of an inch; being .67 of an inch in excess of the normal average precipitation. There were 20 clear days, 4 fair, and 6

cloudy, with 1 day on which rain fell. Highest wind velocity and direction, 24 miles, from the south, on the 17th.

October.—Mean temperature, 63°; 1° warmer than the normal average. Highest and lowest temperature, 86° on the 24th, and 44° on the 11th. Total rainfall, a sprinkle or trace; which was .77 of an inch less than the normal precipitation. There were 27 clear, 3 fair, and 1 cloudy day, with 1 day that a light sprinkle of rain was precipitated. Highest wind velocity and direction, 36 miles, from the northwest, on the 8th.

November.—Mean temperature, 55°; 2° warmer than the normal average. Highest and lowest temperature, 78° on the 1st and 4th, and 36° on the 7th. Total rainfall, nothing, which is 2.09 inches less than the normal precipitation. There were 28 clear, and 2 fair days. Highest wind velocity and direction, 33 miles, from the north, on the 12th. There were thirteen light frosts and no killing ones.

December.—Mean temperature, 43°; 5° cooler than the normal. Highest and lowest temperature, 61° on the 1st, and 33° on the 12th and 31st. Total precipitation, 3.34 inches, which is 1.23 inches less than the normal rainfall. There were 5 clear, 6 fair, and 20 cloudy days, with 5 days upon which an appreciable amount was precipitated. Highest wind velocity and direction, 30 miles, from the southeast, on the 3d. There were four light and no killing frosts.

The last killing frost of spring occurred on the 23d of February, while the last light frost was on the 10th of March.

The first light frost of the present season occurred on the 7th of November. There have been no killing frosts this fall.

The year was, as judged from the monthly average temperatures, 1.2° cooler than the annual normal temperature. Segregated by months, the result would read as follows: January, February, March, June, August, and December were cooler than the average of many years, while April, July, October, and November were warmer than the normal temperature. May was the only month in the year that was equal to the normal, it being exactly the same as the average, as obtained from a record of many years.

RAINFALL IN SACRAMENTO FROM SEPTEMBER, 1849, TO APRIL 10, 1891.

From the records of Dr. T. M. LOGAN, Dr. F. W. HATCH, and the SIGNAL SERVICE:

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of	Total for Season.
1849	------	------	------	------	------	------	------	------	.25	1.50	2.25	12.50	------	1849–50	36.00
1850	4.50	.50	10.00	4.25	.25	none	none	none	none	none	sprin.	sprin.	19.50	1850–51	4.71
1851	.65	.35	1.88	1.14	.69	none	none	none	1.00	.18	2.14	7.07	15.10	1851–52	17.98
1852	.58	.12	6.40	.19	.30	none	none	none	sprin.	none	6.00	13.40	27.00	1852–53	36.36
1853	3.00	2.00	7.00	3.50	1.45	sprin.	sprin.	none	sprin.	sprin.	1.50	1.54	19.99	1853–54	20.06
1854	3.25	8.50	3.25	1.50	.21	.31	none	sprin.	sprin.	1.01	.65	1.15	19.83	1854–55	18.62
1855	2.67	3.46	4.20	4.32	1.15	.01	none	none	sprin.	none	.75	2.00	18.56	1855–56	13.76
1856	4.92	.69	1.40	2.13	1.84	.03	none	none	sprin.	.20	.65	2.40	14.26	1856–57	10.46
1857	1.38	4.80	.68	sprin.	sprin.	.35	none	sprin.	none	.66	2.41	2.63	12.91	1857–58	15.00
1858	2.44	2.46	2.88	1.21	.20	.10	.01	sprin.	sprin.	3.01	.15	4.34	16.80	1858–59	16.03
1859	.96	3.91	1.64	.98	1.04	none	none	none	.02	none	6.48	1.83	16.86	1859–60	22.09
1860	2.31	.93	5.11	2.87	2.49	.02	.63	none	.06	.91	.18	4.28	19.19	1860–61	16.10
1861	2.67	2.92	3.32	.48	.59	.14	.55	none	none	sprin.	2.17	8.64	21.38	1861–62	35.56
1862	15.04	4.26	2.80	.82	1.81	.01	none	.01	none	.36	sprin.	2.53	27.44	1862–63	11.58
1863	1.73	2.75	2.36	1.69	.36	none	none	none	sprin.	none	1.49	1.82	12.20	1863–64	7.87
1864	1.08	.19	1.30	1.08	.74	.09	none	.08	sprin.	.12	6.72	7.87	19.27	1864–65	22.51
1865	4.78	.71	.48	1.37	.46	none	sprin.	none	.08	.48	2.43	.36	11.15	1865–66	17.93
1866	7.70	2.01	2.02	.48	2.25	.10	.02	none	none	sprin.	2.43	9.51	26.52	1866–67	25.30
1867	3.44	7.10	1.01	1.80	.01	none	none	none	.01	none	3.81	12.85	30.03	1867–68	32.79
1868	6.04	3.15	4.35	2.31	.27	sprin.	none	none	none	none	.77	2.61	19.50	1868–69	16.64
1869	4.79	3.63	2.94	1.24	.65	.01	none	none	sprin.	2.12	.85	1.96	18.19	1869–70	13.57
1870	1.37	3.24	1.64	2.12	.27	sprin.	sprin.	sprin.	none	.02	.58	.97	10.21	1870–71	8.47
1871	2.08	1.92	.69	1.45	.76	sprin.	none	none	sprin.	.21	1.22	10.59	18.92	1871–72	23.65
1872	4.04	4.74	1.94	.61	.28	.02	none	none	sprin.	.22	1.93	5.39	19.17	1872–73	14.21
1873	1.23	4.36	.55	.51	none	sprin.	.02	sprin.	none	.31	1.21	10.01	18.20	1873–74	22.90
1874	5.20	1.86	3.05	.89	.37	sprin.	sprin.	none	.05	2.26	3.80	.44	17.92	1874–75	17.70
1875	8.70	.55	.80	sprin.	sprin.	1.10	none	none	none	.44	6.20	5.52	23.31	1875–76	26.53
1876	4.99	3.75	4.15	1.10	.15	none	.21	.02	sprin.	3.45	.30	none	18.12	1876–77	8.96
1877	2.77	1.04	.56	.19	.64	.01	sprin.	sprin.	none	.73	1.07	1.43	8.44	1877–78	24.86
1878	9.26	8.04	3.09	1.07	.17	none	none	none	.29	.55	.51	.47	23.45	1878–79	17.85
1879	3.18	3.88	4.88	2.66	1.30	.13	sprin.	sprin.	none	.88	2.05	3.41	22.37	1879–80	26.47
1880	1.64	1.83	1.70	14.20	.76	none	sprin.	none	none	none	.05	11.81	31.99	1880–81	26.57
1881	6.14	5.06	1.37	1.64	sprin.	.50	sprin.	none	.30	.55	1.88	3.27	20.71	1881–82	16.51
1882	1.89	2.40	3.78	1.99	.35	.10	sprin.	none	.57	2.63	3.22	1.13	18.06	1882–83	18.11
1883	2.23	1.11	3.70	.67	2.85	none	none	none	.90	.96	.61	.44	13.48	1883–84	24.78
1884	3,43	4,46	8.14	4.32	.06	1.45	none	sprin.	.60	2.01	none	10.45	34,92	1884–85	16.58

RAINFALL IN SACRAMENTO—Continued.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1885	2.16	.49	.08	.68	sprin.	.11	sprin.	none	.08	.02	11.34	5.76	20.72	1885–86	32.27
1886	7.95	.29	2.68	4.08	.07	none	none	none	none	.68	.21	2.21	18.17	1886–87	13.97
1887	1.12	6.28	.94	2.53	sprin.	none	none	sprin.	.02	none	.45	2.09	13.43	1887–88	11.56
1888	4.81	.57	3.04	.10	.40	.08	sprin.	sprin.	.55	none	4.28	4.63	18.46	1888–89	19.95
1889	.15	.33	6.25	.26	3.25	.25	none	none	none	6.02	3.15	7.82	27.48	1889–90	32.27
1890	6.62	4.06	3.00	1.33	1.80	none	none	none	.80	sprin.	none	3.34	20.95	1890–91	†15.10
1891	.53	6.61	1.78	*2.04											
Totals	155.42	121.31	122.83	77.42	28.04	4.92	1.44	.11	5.58	32.50	87.89	119.90	804.74		816.62
Averages	3.70	2.89	2.92	1.84	.68	.12	.04	.003	.13	.77	2.09	4.57	19.63		19.92

* Up to May 1, 1891. † Season up to May 1, 1891.

DATE OF FIRST AND LAST LIGHT AND KILLING FROSTS, WITH LOWEST TEMPERATURE AND SNOWFALL, AND DATE OF BLOOMING FRUIT TREES, IN SACRAMENTO, FROM 1869 TO DATE.

From the records of Mr. Samuel H. Gerrish, Voluntary Observer of the Signal Service:

Year.	First Light Frost of the Season.	Minimum Temperature First Light Frost	First Killing Frost of the Season.	Minimum Temperature First Killing Frost	Last Light Frost of the Season.	Minimum Temperature Last Light Frost	Last Killing Frost of the Season.	Minimum Temperature Last Killing Frost	First Appearance of Blossoming Fruit Trees.
1869–70	Nov. 8, 1869	40	November 30, 1869	31	May 17, 1870	41	March 8, 1870	31	Feb. 21, 1870
1870–71	Oct. 24, 1870	36	October 27, 1870	30	April 19, 1871	40	March 18, 1871	31	March 8, 1871
1871–72	Oct. 25, 1871	37	November 6, 1871	30	April 12, 1872	38	January 9, 1872	27	Feb. 26, 1872
1872–73	Oct. 22, 1872	37	November 10, 1872	27	April 6, 1873	34	April 5, 1873	27	Feb. 16, 1873
1873–74	Oct. 16, 1873	33	October 17, 1873	31	April 14, 1874	38	March 19, 1874	28	Feb. 14, 1874
1874–75	Oct. 29, 1874	39	November 20, 1874	29	April 7, 1875	31	April 6, 1875; coldest ever known	24	Feb. 21, 1875
1875–76	Oct. 28, 1875	38	No killing frost; coldest on Dec. 21, 1875	35	April 8, 1876	38	January 16, 1876	29	Feb. 20, 1876
1876–77	Nov. 3, 1876	36	November 13, 1876	29	April 23, 1877	42	February 11, 1877	32	Feb. 2, 1877
1877–78	Oct. 31, 1877	33	November 1, 1877	31	March 9, 1878	39	January 12, 1878	30	Feb. 1, 1878
1878–79	Oct. 18, 1878	37	October 28, 1878	29	April 15, 1879	41	February 6, 1879	27	Feb. 15, 1879
1879–80	Nov. 8, 1879	39	November 27, 1879	25	April 18, 1880	37	March 30, 1880	28	Feb. 29, 1880
1880–81	Oct. 31, 1880	35	November 13, 1880	28	March 18, 1881	33	March 17, 1881	31	Feb. 22, 1881
1881–82	Oct. 4, 1881	36	November 11, 1881	30	May 15, 1882	41	March 9, 1882	29	Feb. 28, 1882
1882–83	Oct. 5, 1882	42	November 13, 1882	27	May 2, 1883	41	February 18, 1883	29	Feb. 19, 1883
1883–84	Oct. 16, 1883	39	November 4, 1883	31	April 17, 1884	43	February 18, 1884	31	Feb. 20, 1884
1884–85	Sept. 30, 1884	41	November 30, 1884	31	April 22, 1885	41	January 26, 1885	31	Feb. 10, 1885
1885–86	Oct. 11, 1885	38	No killing frost; coldest on Dec. 28, 1885	34	April 14, 1886	39	January 10, 1886	27	Feb. 8, 1886
1886–87	Oct. 9, 1886	40	November 4, 1886	32	May 10, 1887	34	February 26, 1887	26	Jan. 28, 1887
1887–88	Oct. 20, 1887	37	November 25, 1887	28	April 26, 1888	38	February 3, 1888	28	Jan. 20, 1888
1888–89	Oct. 19, 1888	37	November 6, 1888	28	March 19, 1889	34	February 19, 1889	26	Feb. 3, 1889
1889–90	Oct. 29, 1889	36	December 29, 1889	27	April 14, 1890	35	February 28, 1890	25	Feb. 13, 1890
1890–91	Oct. 11, 1890	34	November 7, 1890	28	March 30, 1891	34	February 25, 1891	26	Feb. 17, 1891

DATES OF SNOWFALL IN SACRAMENTO, AND THE AMOUNT PRECIPITATED.

January 29, 1862, .75 of an inch. January 12, 1868, 1.62 inches. December 3, 1873, 6.00 inches. April 5, 1875, a trace; enough to whiten the ground before it melted. This was the coldest April ever known. A very light trace on January 13, 1879. January 26, 1880, estimated about .25 of an inch; it mostly melted as it fell. February 17 and 18, 1882, light trace. December 31, 1882, estimated about 4.00 inches; measured 1.50 inches actual measurement. February 1 and 6, 1883, a very light fall of snow. January 4, 1888, 2.89 inches. January 5, 1888, 3.00 inches. The snow that fell on the fifth was very damp and packed hard; if it had been as light as that on the fourth, I think we would have had over 6.00 inches. January 16, 1888, a trace. January 12 and 21, 1890, a few flakes of snow, melting as fast as they fell.

FOLSOM, SACRAMENTO COUNTY.

The rainfall data tabulated below are from Folsom, Sacramento County, and were furnished by J. H. Sturges, special River Observer of the United States Signal Service at that point. The rainfall is from September, 1871, to date:

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1871	--------	--------	--------	--------	--------	--------	--------	--------	sprin.	.55	1.95	13.12	--------	1871–72	28.82
1872	5.50	4.72	1.60	.63	.75	sprin.	none	sprin.	sprin.	.25	2.80	6.53	22.78	1872–73	15.69
1873	1.64	4.05	.34	.05	.03	none	.01	sprin.	sprin.	sprin.	1.39	10.51	18.02	1873–74	24.46
1874	5.26	2.63	1.82	2.03	.81	sprin.	sprin.	none	sprin.	1.66	5.19	.13	19.53	1874–75	15.70
1875	6.14	.04	1.24	sprin.	.07	1.23	none	none	none	.26	7.12	4.49	20.59	1875–76	30.24
1876	5.89	4.06	6.62	1.56	.24	sprin.	.26	.03	none	3.76	.25	none	22.67	1876–77	10.19
1877	3.38	.68	.81	sprin.	1.02	sprin.	sprin.	sprin.	none	.75	.54	1.34	8.52	1877–78	25.00
1878	8.41	8.37	4.23	1.10	.26	none	none	sprin.	.12	.43	.62	.56	24.10	1878–79	21.91
1879	4.87	4.94	5.43	3.38	1.44	.12	none	sprin.	none	1.21	2.20	3.19	26.78	1879–80	25.09
1880	1.51	2.13	1.40	11.39	2.06	none	sprin.	none	none	sprin.	.10	9.85	28.44	1880–81	25.91
1881	6.70	6.07	1.38	1.13	sprin.	.68	none	none	.40	1.21	1.57	3.45	22.59	1881–82	18.68
1882	2.38	3.01	3.82	2.51	.27	.06	sprin.	none	.68	2.81	3.95	.74	20.23	1882–83	22.22
1883	2.11	.80	5.46	1.10	4.57	none	none	none	1.82	1.41	.81	.92	19.00	1883–84	31.02
1884	3.88	5.92	8.14	5.32	1.16	1.64	none	sprin.	.64	2.02	none	6.13	37.85	1884–85	16.58
1885	1.91	.84	.15	1.68	sprin.	.21	.02	sprin.	.21	sprin.	10.91	4.88	20.81	1885–86	34.75
1886	7.60	.90	3.16	6.78	.29	none	none	none	none	1.34	.55	3.35	23.97	1886–87	20.11
1887	1.27	9.21	1.30	2.84	.03	.22	none	sprin.	.38	none	.59	4.82	20.66	1887–88	16.28
1888	5.83	.84	3.08	.12	.35	.27	.02	.01	.57	none	3.71	4.32	19.12	1888–89	20.43
1889	.32	.68	7.07	.61	2.89	.23	none	none	none	5.70	4.85	9.41	31.36	1889–90	42.95
1890	7.67	5.26	5.68	2.09	2.29	none	none	sprin.	1.58	.03	none	4.65	29.25	1890–91	*6.26

Average seasonal precipitation for nineteen years is 23.47 inches.

* Up to January 1, 1891.

WALLA WALLA CREEK, SISKIYOU COUNTY, CAL.

Weather summary for the year 1890, at Walla Walla Creek (near Fort Jones). By Isaac Titcomb, Observer:

Month.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Clear Days	Fair Days	Cloudy Days	Rainy Days	Prevailing Wind—Direction
January	33.0	22.9	25.88	44	6	11.86	2	5	9	‡13	N.
February	40.7	24.1	29.46	48	3	9.10	11	10	2	5	S.
March	48.1	29.2	34.85	60	15	4.93	10	4	5	12	S.
April	61.2	34.8	44.15	76	23	1.24	16	5	7	2	S.
May	72.0	44.9	55.23	87	32	1.29	18	5	5	3	S.
June	74.8	44.7	56.47	94	32	.28	13	12	5	2	S.
July	83.7	51.2	64.43	94	40	.00	30	1	0	0	N.
August	83.6	53.2	64.69	92	39	.85	20	6	5	0	N.
September	78.8	49.7	60.73	86	42	1.84	26	1	2	2	N.
October	62.2	38.3	47.00	69	28	.10	18	9	4	0	N.
November	55.0	34.2	41.54	66	24	.19	19	8	1	2	S.
December	41.1	30.9	34.40	52	16	3.85	3	4	19	5	S.
For the year	61.2	38.2	46.57	*94	†3	35.53	186	70	64	46	S.

There were three killing frosts (in October), and ten light frosts (three in June and seven in October).

* June. † February. ‡ Snow.

RAINFALL IN SCOTT VALLEY, SISKIYOU COUNTY, CAL.

By Mr. Isaac Titcomb, of Walla Walla Creek, eight miles northwest of Fort Jones:

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1859	--------	--------	--------	--------	--------	--------	--------	.50	.87	1.00	4.33	.75	--------	1859–60	18.66
1860	2.59	1.25	4.12	.75	2.00	.40	1.62	.24	.49	2.22	2.00	5.74	23.52	1860–61	22.27
1861	1.12	2.50	2.50	3.00	.54	.30	none	none	none	.51	11.56	10.63	32.66	1861–62	40.86
1862	9.29	3.75	1.32	2.00	1.00	.80	.10	none	.02	.15	.12	1.90	20.45	1862–63	15.57
1863	4.75	1.75	2.45	2.00	.40	1.93	.25	.09	.40	.25	1.85	6.17	22.29	1863–64	15.85
1864	2.07	.43	.82	2.70	.51	.31	none	.03	.04	.31	6.00	12.75	26.57	1864–65	25.82
1865	1.87	2.40	1.30	.32	.05	.75	.35	.02	1.15	1.33	9.79	1.21	20.54	1865–66	35.50
1866	6.59	3.50	9.20	.02	1.72	.62	.50	.47	none	.08	2.51	11.75	36.96	1866–67	28.88
1867	9.12	2.02	.64	1.34	.44	.01	none	.26	.40	.88	1.75	9.68	26.54	1867–68	23.61
1868	3.06	1.50	3.70	1.14	.18	1.06	none	none	.06	.50	.77	2.80	14.77	1868–69	18.16
1869	5.76	1.13	1.32	3.61	1.52	.69	.13	none	1.00	.01	3.04	3.56	21.77	1869–70	20.00
1870	5.00	2.91	1.73	1.37	1.12	.13	none	none	.01	.02	1.00	3.50	16.79	1870–71	13.56
1871	1.86	2.47	1.62	2.27	.55	.26	.35	none	.37	.05	1.62	7.68	19.10	1871–72	23.21
1872	4.18	6.94	1.40	.34	.25	.03	.01	.01	.41	.16	2.67	3.38	19.78	1872–73	13.82
1873	1.33	3.00	1.05	1.50	.27	.03	.03	.05	.37	.94	1.71	4.49	14.77	1873–74	21.81
1874	6.38	1.80	3.65	1.55	.71	.13	.01	.09	none	1.55	4.33	.43	20.63	1874–75	12.72
1875	3.13	.17	1.79	.35	.75	.12	.38	.05	none	4.45	7.31	7.33	25.83	1875–76	31.13
1876	2.26	3.35	3.94	.71	1.19	.18	.34	1.00	1.02	3.75	.54	.01	18.27	1876–77	19.12
1877	1.71	4.23	3.10	1.23	1.48	.71	.12	.02	.01	.45	.67	1.62	15.35	1877–78	23.47
1878	9.72	6.53	3.74	.27	.20	.12	.01	.06	.36	2.81	2.16	1.14	27.12	1878–79	26.05
1879	3.25	3.54	8.39	2.66	1.40	.27	.38	.47	.11	.81	4.64	4.58	30.50	1879–80	33.31
1880	10.62	2.32	2.65	5.39	1.32	.02	.37	.07	none	.18	.32	6.76	30.02	1880–81	31.37
1881	13.95	6.53	.79	1.19	.17	1.04	.54	.04	.76	3.53	2.40	4.60	35.54	1881–82	28.08
1882	4.48	5.69	2.22	2.45	1.29	.08	2.49	none	1.44	2.86	2.72	3.75	29.47	1882–83	24.36
1883	2.58	1.51	1.11	3.25	2.65	none	.40	.63	.66	2.41	1.11	4.75	21.06	1883–84	26.41
1884	4.28	3.14	3.45	3.06	1.65	.87	1.62	.01	.60	1.04	.16	8.18	28.06	1884–85	22.49
1885	2.50	3.49	.11	1.98	1.40	1.40	1.16	.01	.83	.53	10.24	3.26	26.91	1885–86	30.92
1886	7.22	1.32	1.32	3.23	1.77	.03	2.13	.85	none	1.85	.78	6.67	27.17	1886–87	27.40
1887	5.18	4.96	1.07	2.63	.94	.36	.37	.18	.36	.09	1.75	5.88	23.77	1887–88	25.20
1888	6.18	1.77	2.43	.18	1.80	4.21	.60	.11	.58	.40	1.94	1.59	21.79	1888–89	20.24
1889	2.71	.50	4.35	2.56	4.71	.19	1.11	none	none	3.95	3.37	12.84	27.74	1889–90	49.97
1890	11.86	9.10	4.93	1.24	1.29	.28	none	.85	1.84	.10	.19	3.85	35.53	1890–91	*6.83

*Up to January 1, 1891.

CRESCENT CITY, CAL.

Weather summary for the year 1890, at Crescent City, Cal. By D. E. Sartwell, Observer:

Month.	Total Precipitation	Clear Days	Fair Days	Cloudy Days	Rainy Days	Light Frosts	Killing Frosts	Prevailing Wind—Direction
January	24.98	2	1	28	26	0	10	S.
February	23.49	5	4	19	17	4	2	N.W.
March	13.51	8	4	19	17	7	0	S.
April	4.07	11	7	12	5	3	0	N.W.
May	.52	12	11	8	6	0	0	N.W.
June	2.27	12	9	9	5	0	0	N.W.
July	.33	6	15	10	2	0	0	S.
August	.06	8	12	11	1	0	0	S.
September	.42	6	5	19	1	0	0	S.
October	1.11	19	8	4	3	8	0	N.W.
November	.08	19	7	4	1	7	0	N.W.
December	9.66	9	13	9	15	13	0	S.
For the year	80.50	117	96	152	99	45	12	S&NW

Average temperature for nine years, 78.6°.

HYDESVILLE, CAL.

Weather summary for the year 1890, at Hydesville, Cal. By E. T. Foss, Observer:

MONTH.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Rainy Days	Light Frosts	Killing Frosts
January	46.0	32.9	39.5	53	24	17.31	25	--------	5
February	51.7	34.9	43.3	63	24	10.13	17	3	8
March	55.4	36.7	46.1	64	29	8.62	18	3	8
April	58.5	41.7	50.1	70	29	1.63	5	--------	5
May	66.2	47.6	56.9	86	39	1.58	5	--------	--------
June	66.1	46.4	56.8	78	39	.67	4	--------	--------
July	67.3	49.3	58.8	72	45	.15	1	--------	--------
August	68.7	48.9	58.8	76	39	.00	0	--------	--------
September	68.4	43.9	56.1	81	39	1.51	2	--------	--------
October	65.6	40.6	53.1	79	30	.04	0	6	3
November	62.9	37.8	50.3	72	29	.49	2	8	7
December	56.1	38.1	47.1	63	30	5.85	8	5	9
For the year	61.1	41.5	51.3	*86	†24	47.98	87	25	45

* In May. † In January and February.

EUREKA, CAL.

Meteorological data furnished by MAURICE CONNELL, Observer Signal Corps in charge:

1890.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Average.
Mean barometer	29.97	30.01	30.02	30.06	29.98	30.04	30.03	29.97	29.93	30.03	30.09	30.04	30.01
Mean temperature	42.2	44.4	46.9	49.0	54.0	55.2	56.7	55.8	53.2	51.6	50.0	48.4	50.6
Mean dew point	37.0	39.0	41.0	44.0	49.0	50.0	53.0	53.0	51.0	48.0	47.0	45.0	46.0
Mean humidity	84.0	81.0	81.0	85.0	86.0	85.0	89.0	91.0	95.0	92.0	91.0	90.0	88.0
Mean maximum temperature	48.0	50.2	53.7	53.8	59.3	60.0	61.1	60.1	57.3	58.2	56.6	54.4	56.1
Mean minimum temperature	36.3	38.6	40.1	44.2	48.8	50.5	52.3	51.5	49.1	45.0	43.5	42.3	45.2
Highest temperature	54.0	59.0	60.0	63.0	78.0	65.0	65.0	65.0	69.0	70.0	66.0	66.0	78.0
Lowest temperature	28.0	27.0	31.0	35.0	41.0	45.0	48.0	45.0	46.0	38.0	35.0	36.0	27.0
Mean daily range of temperature	11.7	11.6	13.6	9.6	10.5	9.5	9.5	8.6	8.3	13.1	13.1	12.1	10.9
Total monthly velocity of wind	5,752	4,997	4,685	5,955	5,775	6,117	5,163	3,969	2,808	3,800	2,905	3,368	55,394
Maximum velocity of wind	36	35	35	42	35	35	25	25	34	35	36	37	42
Direction of maximum velocity	N.W.	N.	S.W.	N.	N.	N.	N.	N.	N.W.	N.	N.	S.	N.
Prevailing winds	S.E.	N.	S.E.	N.	N.W.	N.W.	N.W.	N.W.	N.W.	N.	N.	S.E.	N.
Clear days	3	5	5	5	5	8	6	5	4	11	15	8	80
Fair days	7	9	13	6	14	12	13	12	4	14	5	12	121
Cloudy days	12	14	13	19	12	10	12	14	22	6	10	11	164
Rainy days	25	19	19	7	7	9	2	2	4	3	4	14	115
Total precipitation	18.26	13.88	11.57	2.26	1.71	.87	.08	.02	.79	.44	.18	5.48	55.54
Greatest amount in twenty-four hours	3.70	.81	2.90	1.37	.83	.35	.06	.01	.68	.41	.08	2.21	--------

NOTE.—Barometer corrected for temperature and instrumental error only.

ARCATA, HUMBOLDT COUNTY, CAL.

Arcata is geographically situated in latitude 40° 49′ north, longitude 124° 10′ west. The following summaries of rainfall by seasons is furnished by Herman Fry, Observer:

SUMMARY FOR 1886–87. SEASON BEGAN OCTOBER 22, 1886.

Month.	Number of Wet Days.	Precipitation.
1886—October	9	3.19
November	4	1.77
December	22	9.03
1887—January	26	9.43
February	24	8.73
March	15	2.65
April	15	6.49
May	9	2.65
June	5	1.96
Total	----------	45.90

SUMMARY FOR 1887–88. SEASON BEGAN SEPTEMBER 6, 1887.

Month.	Number of Wet Days.	Precipitation.
1887—September	2	.46
October	2	.44
November	6	3.40
December	20	7.47
1888—January	20	11.36
February	10	2.57
March	6	2.77
April	5	1.37
May	4	.90
June	13	4.85
Total	----------	35.59

SUMMARY FOR 1888–89. SEASON BEGAN OCTOBER 6, 1888.

Month.	Number of Wet Days.	Precipitation.
1888—October	5	1.41
November	12	3.40
December	12	4.79
1889—January	11	4.38
February	7	1.70
March	12	5.75
April	10	3.85
May	14	7.23
June	2	.52
Total	----------	33.03

Summary for 1889–90. Season Began October 7, 1889.

Month.	Number of Wet Days.	Precipitation.
1889—October	13	8.27
November	10	3.61
December	22	12.57
1890—January	25	16.85
February	18	14.78
March	18	11.94
April	7	2.26
May	5	2.05
June	5	1.18
Total		73.51

Season of 1890–91. Began September 29, 1890.

Month.	Number of Wet Days.	Precipitation.
1890—September	2	.92
October	3	.45
November	4	.22
December	12	4.84
1891—January	13	3.62
Total for season up to March 1, 1891		10.05

SUSANVILLE, LASSEN COUNTY, CAL.

Weather summary at Susanville, for the year 1890. By T. B. Saunders, Voluntary Observer:

Months.	Highest Temperature	Lowest Temperature	Mean Temperature	Rain	Snow—Inches	Direction of Wind	Date of Frosts	Number of Days Snow Fell	Snow at End of Month—Inches	Thunder Storms
January	47	8	20	6.72	76½	N.		24	26	
February	54	10	28	5.20	51	N.		16	18	
March	58	12	31	4.70	14½	N.		10		
April	78	32	50	1.06		N.				
May	89	33	61	1.51		N.		8	1	2
June	88	42	62	.14		N.	*1st, 2d	1		2
July	100	60	73			N.				
August	98	56	75	.15		N.		1		1
September	89	53	69	.15		N.	†29th	2		3
October	76	36	57	trace		N.	‡9th			
November	70	27	42	.25	3½	N.		1		
December	62	12	34	3.37	15½	N.				
For the year	909	360	602	23.30	151			66		8

* No damage done to fruits or vegetables. † No damage. ‡ First killing frost of the season.

VALLEY SPRINGS, CAL.

The following table of rainfall is from record kept by H. W. Turner, from July, 1887, to December, 1890:

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1887							none	none	none	none	.72	3.51		1886-87	
1888	5.02	.79	1.74	1.94	.23	shower	none	none	.47	none	2.44	2.29	14.92	1887-88	13.95
1889	.28	.77	4.96	.68	2.67	none	none	none	none	4.24	4.34	9.24	27.20	1888-89	14.58
1890	7.21	3.73	5.51	2.12	2.44	none	none	none	1.16	none	none	3.54	25.71	1890-91	

ANNUAL METEOROLOGICAL REVIEW FOR RED BLUFF, TEHAMA COUNTY, CAL.

The following table shows the climatic condition in all its features for fourteen years, from 1877 to 1890, both years inclusive, at Red Bluff, California. Furnished by JOHN J. MCLEAN, Observer Signal Corps:

ANNUAL WEATHER REVIEW FOR:	*1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
Average barometer		29.58	29.64	29.65	29.65	29.64	29.67	29.62	29.65	29.65	29.64	29.97	29.62	29.66
Highest barometer	30.03	30.14	30.30	30.14	30.12	30.14	30.34	30.22	30.09	30.10	30.14	30.64	30.05	30.13
Lowest barometer	29.23	29.00	28.97	29.03	29.19	29.30	29.21	28.98	28.07	28.99	29.08	29.52	29.04	28.94
Range of barometer		1.14	1.32	1.11	.93	.85	1.13	1.24	1.02	1.11	1.06	1.12	1.01	1.19
Average temperature		64.0	63.3	61.2	62.1	60.2	61.5	60.8	64.4	63.2	64.4	64.5	63.2	61.5
Highest temperature	108.0	110.5	110.0	108.0	103.0	105.0	107.0	107.0	108.0	109.0	111.5	109.0	111.0	110.0
Lowest temperature	32.0	25.0	25.0	26.0	31.0	25.0	19.0	22.0	33.0	30.0	27.3	17.5	26.0	22.0
Range of temperature		85.5	85.0	82.0	72.0	80.0	88.0	85.0	75.0	79.0	84.2	91.5	85.0	88.0
Greatest monthly range of temp.	54.0	55.0	54.0	53.5	53.0	57.0	58.0	57.0	56.0	54.4	70.4	55.1	61.0	57.0
Least monthly range of temp.	34.0	25.0	36.0	27.5	32.5	30.0	39.0	35.5	32.5	34.5	35.9	25.6	26.0	32.0
Average maximum temperature		86.9	89.2	86.7	86.0	83.7	87.2	72.0	75.3	76.2	75.6	75.1	75.0	73.3
Average minimum temperature		41.4	41.3	39.8	41.1	39.5	39.8	49.7	52.8	52.4	51.4	52.2	51.4	49,7
Average range of temperature		45.5	47.8	47.0	45.1	43.9	47.3	44.0	44.8	46.6	50.0	46.2	47.0	23.7
Average humidity		53.2	52.5	51.4	55.1	58.0	55.1	59.3	57.5	55.3	47.0	52.5	56.0	58.0
Average dew point							41.5	43.5	45.2	42.8	39.5	41.7	42.0	43.0
Prevailing direction of wind	N.	N.	N.	N.	N.	N.	N.	N. & S.	S.	N.	N.	N.	N.W.	N.W.
Total precipitation	8.54	49.01	33.64	26.53	24.93	21.82	13.76	28.06	29.63	17.21	13.60	24.94	32.87	25.60
Total velocity of wind	28,805	70,220	*a*	*b*20,379	49,088	45,879	54,948	58,145	51,924	54,690	63,705	57,769	59,769	62,122
Maximum velocity of wind	30	46	52	60	42	40	36	48	44	50	45	45	44	48
Direction at time of max. velocity	N.	S.E.	S.	S.E.	S.	S.	S.	S.	S.	S.E.	N. & S.	N. & S.	S.E.	S.E.
Clear days	128	232	207	230	204	215	261	225	223	212	213	207	205	218
Fair days	32	72	90	74	103	89	67	84	96	91	98	89	70	89
Cloudy days	24	61	68	58	58	43	37	53	46	59	54	68	90	58
Days of precipitation	27	79	83	66	72	69	44	71	70	63	57	91	97	79
Thunder and lightning	*a*	*a*	*a*	*a*	*a*	7	7	7	7	3	5	10	5	4
Days temperature above 90°	69	93	84	71	59	60	94	53	77	89	99	88	108	86
Days temperature below 32°	0	12	16	26	1	17	33	15	0	7	12	14	10	26

* Station opened July 1, 1877—six months, 1877. *a* No record. *b* Five months.

RAINFALL AT RED BLUFF, TEHAMA COUNTY, CAL.

This table is made up from the Signal Service records, and shows the total rainfall for each calendar year from 1878 to date, and the rainfall by seasons from 1877-78 to date; also the totals for each month, with the averages from the opening of the Signal Office on July 1, 1877, to date. Prepared by John McLean, Observer Signal Corps:

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1877	-------	-------	-------	-------	-------	-------	.05	.03	none	1.35	3.13	3.98	-------	1877-78	53.17
1878	20.71	16.66	4.16	2.21	.89	none	none	none	.42	1.56	1.66	.69	48.96	1878-79	21.17
1879	3.18	3.67	5.39	2.12	2.18	.30	.04	.28	sprin.	.48	6.05	9.95	33.64	1879-80	30.26
1880	2.01	1.66	1.70	7.05	1.04	none	none	none	none	.08	.14	12.85	26.53	1880-81	28.90
1881	9.40	2.79	.51	1.83	.79	.51	sprin.	none	1.07	1.61	.73	5.69	24.93	1881-82	21.12
1882	2.81	3.94	2.67	2.12	.33	.15	none	none	.49	2.80	5.07	1.44	21.82	1882-83	18.58
1883	.87	.39	2.60	1.96	2.96	none	none	none	1.04	2.68	.74	.52	13.76	1883-84	24.01
1884	3.55	2.21	7.81	4.31	.18	.97	none	none	.36	.90	.04	7.73	28.06	1884-85	14.69
1885	1.84	1.19	sprin.	.62	.64	1.37	.05	none	2.91	.10	17.05	3.90	29.67	1885-86	35.15
1886	4.80	.18	1.31	4.12	.73	sprin.	sprin.	sprin.	none	1.76	.34	3.94	17.18	1886-87	15.74
1887	.57	5.21	1.13	1.76	.77	.26	sprin.	sprin.	.06	none	1.52	2.32	13.60	1887-88	17.27
1888	4.08	2.17	3.47	.53	.51	2.61	.07	none	.33	sprin.	4.32	6.85	24.94	1888-89	23.41
1889	.51	.71	6.83	1.11	2.04	.64	none	none	none	8.41	3.37	9.25	32.87	1889-90	41.85
1890	6.53	3.67	6.14	1.70	2.67	.11	none	none	1.55	.01	none	3.20	25.60	1890-91	*4.76

* Up to January 1, 1891.

WILLOWS, CAL.

Weather summary for the year 1890, at Willows, Cal. By A. W. Sehorn, Observer:

Month.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Clear Days	Fair Days	Cloudy Days	Rainy Days	Light Frosts	Killing Frosts	Prevailing Wind—Direction
January	46	36	41	55	28	4.52	9	8	14	9	5	4	S.E.
February	54	37	46	69	26	2.70	18	2	8	4	6	3	N.
March	62	41	51	72	28	4.74	14	2	15	9	4	2	S.
April	70	45	58	81	37	.62	9	8	13	2	0	0	N.
May	78	55	67	99	43	1.89	9	8	14	6	0	0	S.E.
June	88	57	73	101	43	.20	19	8	3	1	0	0	S.E.
July	94	60	77	107	54	.00	27	3	1	0	0	0	N.
August	93	61	77	101	55	T.	28	2	1	1	0	0	S.
September	83	60	72	97	56	.68	23	3	4	2	0	0	S.
October	81	48	64	86	38	.00	23	8	0	0	0	0	N.
November	70	39	55	82	35	T.	16	10	4	0	0	0	N.
December	50	37	43	67	28	3.14	3	4	24	5	5	3	N.
For the year	72	48	60	86	39	19.49	198	66	101	37	20	12	N.

Note.—The temperature was low enough for frost in November, but the atmosphere was so dry there was no frost until December fourth.

COLUSA, COLUSA COUNTY, CAL.

The rainfall, etc., from Colusa was furnished by J. D. McNary. The table gives the rainfall by seasons from 1872–73 to date, and by months from 1881 to date:

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1872														1872–73	33.46
1873														1873–74	11.28
1874														1874–75	19.02
1875														1875–76	19.79
1876														1876–77	9.20
1877														1877–78	33.34
1878														1878–79	13.98
1879														1879–80	19.21
1880														1880–81	16.96
1881	3.70	2.27	.60	1.42	.34	none	none	none	1.19	none	.43	2.51	12.46	1881–82	22.62
1882	1.51	2.56	2.50	1.27	.04	.65	none	none	.23	1.10	1.73	.69	12.37	1882–83	11.66
1883	1.07	.37	2.36	.79	3.23	none	none	none	.68	.68	.11	.10	9.39	1883–84	29.75
1884	4.82	2.30	5.70	2.97	.12	2.88	none	none	.59	1.06	none	5.30	25.74	1884–85	11.69
1885	2.04	.58	.35	1.22	none	.55	none	none	.02	.79	7.69	3.98	17.22	1885–86	21.64
1886	4.57	.20	.64	3.65	.10	none	none	none	none	.65	none	1.25	11.06	1886–87	11.37
1887	.42	5.97	1.17	1.91	none	none	none	none	none	none	.60	1.90	11.97	1887–88	10.65
1888	3.32	1.08	2.46	.30	.60	.39	none	none	.74	none	3.83	5.69	18.41	1888–89	17.77
1889	.30	.43	5.36	.33	.72	.37	none	none	none	6.35	2.64	7.75	24.25	1889–90	35.00
1890	6.27	3.03	4.08	1.48	2.15	1.25	none	.04	.77	none	none	2.94	22.01	1890–91	*3.71

Average seasonal precipitation for eighteen years is 19.35 inches.

* Up to January 1, 1891.

THE TEMPERATURE, RAINFALL, ETC., AT MARYSVILLE, IN 1890.

"Appeal" Office, Observer.

The year just closed was chiefly remarkable, in respect to weather, for the unusually large number of rainy days in the first three months of the year, and for the uncommonly gloomy weather in December. The winter of 1889–90 will long be remembered as one of the most disagreeable in the history of Marysville. The following table gives a summary of the local weather record. Despite the bad beginning of the year, it will be observed that the total number of clear days was two hundred and twenty-four, which compares very favorably with the average for Mediterranean health resorts:

Summary for 1890.

MONTH.	Highest Temperature	Lowest Temperature	Average Temperature	Clear Days	Fair Days	Cloudy Days	Days on which Rain Fell	Rainfall
January	54	28	41.4	10	6	15	15	5.59
February	64	29	46.7	10	5	13	8	4.71
March	71	36	53.0	14	8	9	15	4.78
April	83	44	60.7	21	7	2	2	1.83
May	96	48	66.1	19	8	4	4	2.44
June	94	47	69.6	29	1	0	1	.09
July	101	57	75.9	30	0	1	0	--------
August	94	57	75.6	26	0	5	0	--------
September	92	56	73.0	16	7	7	2	.91
October	85	42	63.0	22	9	0	0	--------
November	75	38	53.4	22	7	1	0	--------
December	58	34	43.9	5	8	18	7	2.95
For 1890	101	28	60.4	224	66	75	54	23.30
For 1889	103	31	62.0	249	52	64	68	32.13

WHEATLAND, CAL.

Weather summary for the year 1890, at Wheatland. By WILLIAM LUMBARD, Observer:

MONTH.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Rainy Days	Prevailing Wind—Direction
January	47.0	34.8	40.9	57	27	4.75	19	S.
February	52.8	38.3	45.6	66	28	4.17	8	S.
March	59.2	42.6	50.9	69	36	4.45	16	S.E.
April	69.1	47.8	58.4	83	39	1.40	3	S.E.
May	76.0	54.5	65.2	102	45	1.84	4	S.
June	83.7	55.0	69.3	98	45	--------	--------	S.E.
July	90.0	59.3	74.6	106	52	--------	--------	S.
August	90.8	59.9	75.3	99	53	--------	--------	S.
September	86.8	56.2	71.5	97	51	1.01	2	S.E.
October	79.0	47.9	63.4	89	42	--------	--------	N.
November	68.9	38.7	53.8	84	35	--------	--------	N.
December	48.5	35.9	42.2	61	30	2.19	8	N.
For the year	70.9	47.5	59.2	*106	†27	19.81	60	S.

*In July. †In January.

WEST BUTTE, SUTTER COUNTY, CAL.

The report of rainfall at West Butte, Sutter County, was furnished by A. S. Noyes, and covers a period from November, 1879, to date:

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1879	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.38	2.25	-----	1879–80	13.25
1880	.62	.75	.75	5.88	.62	none	none	none	none	none	none	5.38	14.00	1880–81	12.20
1881	3.69	1.38	.75	1.06	none	none	none	none	.31	1.12	.38	2.00	10.63	1881–82	12.26
1882	1.88	2.31	2.57	1.19	.50	none	none	none	.25	.88	2.62	.25	12.45	1882–83	12.44
1883	.75	.19	3.06	.88	3.56	none	none	none	.62	.81	none	.19	10.06	1883–84	19.80
1884	3.81	2.12	6.50	3.75	.25	1.75	none	none	.57	1.00	none	4.94	24.69	1884–85	12.13
1885	2.00	.50	.37	2.12	.18	.45	none	none	.18	.56	7.45	3.65	17.46	1885–86	23.10
1886	4.75	.70	1.50	4.19	.12	none	none	none	none	.50	.44	.67	12.87	1886–87	11.19
1887	.50	6.06	.82	2.20	none	none	none	none	none	none	.75	1.50	11.83	1887–88	10.55
1888	3.55	1.12	2.67	.30	.36	.30	none	none	.75	none	3.25	6.00	18.30	1888–89	18.84
1889	.12	.36	5.78	.63	1.45	.50	none	none	none	4.75	3.00	7.37	23.96	1889–90	31.14
1890	5.45	2.59	4.14	1.59	2.02	.23	none	.04	.87	none	none	2.49	19.42	1890–91	*3.40

Average precipitation by seasons for eleven years is 16.39 inches.

* Up to January 1, 1891.

GRASS VALLEY, NEVADA COUNTY, CAL.

The rainfall that goes to make up the following table for Nevada County was taken at Grass Valley, by Mr. W. Loutzenheiser, beginning with January, 1873, to date:

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1873	4.01	12.50	1.39	2.32	2.56	none	none	none	none	.83	2.99	19.01	45.61	1872–73	40.00
1874	13.71	6.93	11.71	3.76	1.05	.10	none	none	none	2.95	15.91	1.08	57.20	1873–74	60.09
1875	15.56	1.39	4.14	.29	1.18	2.28	none	none	none	.97	16.99	7.44	50.24	1874–75	44.78
1876	12.01	10.75	12.47	2.80	1.23	.65	none	none	.06	8.72	.62	none	49.31	1875–76	65.31
1877	10.18	2.44	4.79	1.14	1.40	.74	none	none	none	1.21	3.78	1.74	27.42	1876–77	30.09
1878	15.74	17.76	10.18	2.78	.59	none	none	none	.68	2.09	2.54	.75	53.11	1877–78	53.78
1879	10.72	11.51	18.07	7.08	3.08	.30	none	.08	none	2.79	6.54	8.86	69.03	1878–79	56.82
1880	6.40	4.83	4.07	23.31	6.23	.09	none	none	none	.04	.30	22.69	67.96	1879–80	63.20
1881	19.20	8.50	3.33	1.85	.05	1.50	none	none	1.25	3.71	3.52	8.21	51.12	1880–81	57.46
1882	6.03	6.30	7.96	5.29	1.18	.05	none	none	1.88	7.88	4.78	2.83	44.61	1881–82	43.93
1883	3.05	2.97	9.25	2.38	5.77	none	none	none	1.44	3.03	1.48	2.31	31.68	1882–83	40.79
1884	7.80	10.27	13.98	10.98	1.00	2.30	none	none	.98	3.30	.05	28.39	79.05	1883–84	54.59
1885	3.65	1.76	.83	3.17	.16	.90	none	none	2.65	none	19.27	6.36	38.75	1884–85	43.19
1886	12.40	1.43	4.83	11.38	1.09	none	none	none	none	1.66	.67	5.46	38.92	1885–86	59.41
1887	3.38	15.72	1.69	6.54	.64	.52	none	none	.26	none	1.38	6.85	36.98	1886–87	36.28
1888	11.81	2.59	5.22	.50	.38	2.21	.06	none	.50	none	4.03	7.94	35.24	1887–88	31.20
1889	.58	.97	11.93	3.56	7.36	none	none	none	none	12.00	8.37	19.23	63.80	1888–89	35.76
1890	18.64	10.02	13.69	3.52	3.10	.02	none	none	1.95	none	none	4.42	55.36	1889–90	88.59
1891														1890–91	*6.37

* Up to January 1, 1891.

RAINFALL AT WOODLAND, YOLO COUNTY, SINCE 1873.

Taken from J. B. Elston's record, which is the standard gauge for Yolo County:

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1873	1.25	2.84	.56	.18	none	none	none	none	none	.20	1.15	10.44	16.62	1872–73	10.22
1874	5.99	1.33	2.85	.64	.40	none	none	none	none	3.26	2.79	.16	17.42	1873–74	23.00
1875	5.22	.35	.66	none	.15	1.59	none	none	none	.44	3.87	2.49	14.77	1874–75	14.18
1876	4.40	4.85	4.24	1.40	.45	none	.16	none	.17	3.37	.27	none	19.31	1875–76	22.30
1877	3.95	1.42	.77	.03	.53	none	none	none	none	.94	1.10	1.29	10.03	1876–77	10.51
1878	11.52	7.61	2.30	1.25	.68	done	none	none	.25	.34	.88	.01	24.84	1877–78	26.69
1879	2.62	3.25	4.48	2.40	1.70	none	none	none	none	.22	7.15	3.66	20.48	1878–79	16.23
1880	1.33	1.22	.97	6.84	.28	none	none	none	none	none	none	8.73	19.37	1879–80	16.57
1881	4.50	1.93	.97	1.39	none	.35	none	none	.50	.25	1.87	2.37	14.13	1880–81	17.87
1882	1.24	1.87	2.34	1.51	.03	.07	none	none	.82	2.04	2.42	1.05	13.39	1881–82	12.25
1883	.91	.60	3.24	1.22	4.65	none	none	none	.54	1.04	.30	.54	13.04	1882–83	16.75
1884	3.67	4.07	6.53	4.03	none	3.02	none	none	.22	1.61	none	5.57	27.73	1883–84	22.75
1885	1.62	.15	.15	1.50	none	none	none	none	.06	.05	9.14	2.73	15.40	1884–85	10.82
1886	5.81	none	1.71	4.14	none	none	none	none	none	.59	none	1.39	13.64	1885–86	23.64
1887	.88	7.56	.75	1.90	none	none	none	none	none	none	.60	3.67	15.36	1886–87	13.07
1888	3.88	.97	2.80	.10	.77	none	none	none	.56	none	6.25	4.51	19.84	1887–88	12.79
1889	.19	.49	6.14	.84	2.01	.43	none	none	none	5.54	3.54	8.16	27.34	1888–89	21.42
1890	5.30	4.37	3.42	.95	1.68	none	none	none	.42	none	none	3.04	19.18	1889–90	32.96
1891														1890–91	*3.46

Average precipitation for eighteen seasons is 18 inches.

* Up to January 1, 1891.

WEATHER AT IOWA HILL, PLACER COUNTY, CAL.

Summary of the weather record kept by C. F. MACY, at Iowa Hill, Placer County, for the year 1890. Altitude, 2,825 feet above sea level:

Month.	Clear Days	Fair Days	Cloudy Days	Rainy Days	Precipitation—Inches	Highest Temperature. 7 A. M.	Highest Temperature. 2 P. M.	Highest Temperature. 9 P. M.	Lowest Temperature. 7 A. M.	Lowest Temperature. 2 P. M.	Lowest Temperature. 9 P. M.	Mean Temperature. 7 A. M.	Mean Temperature. 2 P. M.	Mean Temperature. 9 P. M.	Light Frosts	Killing Frosts	Prevailing Wind.
January	7	4	20	18	20.87	41	51	43	22	33	27	31.12	40.16	34.13	7	19	S.
February	10	5	13	13	10.74	52	67	52	22	34	28	37.18	48.07	39.00	3	11	S.
March	8	7	16	14	14.12	50	69	50	31	37	33	42.10	53.87	43.74	1	3	S.
April	19	1	10	5	3.02	62	83	63	41	41	42	50.30	67.13	52.16	0	0	S. to S.W. day, N. to N.E. night.
May	19	4	8	7	3.48	76	91	76	41	45	40	58.71	73.84	59.61	0	0	N. to N.E.
June	27	1	2	1	.08	77	94	77	48	58	47	62.66	79.33	63.23	0	0	N. to N.E.
July	30	1	0	0	------	80	101	84	62	75	61	71.61	90.39	71.77	0	0	N. to N.E.
August	29	1	1	0	------	76	96	77	56	81	62	70.21	89.22	72.13	0	0	N. to N.E.
September	19	2	9	3	2.29	72	93	75	54	57	55	75.23	84.70	68.47	0	0	N. to N.E.
October	26	4	1	1	2.64	64	86	69	45	54	45	54.55	74.84	58.68	0	0	N. to N.E.
November	26	4	0	0	------	62	82	64	36	53	43	51.23	71.56	54.76	1	0	S. to S.W.
December	17	3	11	6	7.34	52	67	57	33	40	38	43.80	58.42	46.13	3	1	S. to S.W.
For the year	237	37	91	68	64.58	63.67	81.67	65.88	40.91	50.67	43.41	53.23	69.29	55.31	15	34	----------

Annual mean temperature at above hours, 61.78°.

RAINFALL AT IOWA HILL, PLACER COUNTY, CAL.

Record of rainfall kept by C. F. Macy, from January 1, 1879, to June 1, 1883, at Strawberry Flat, near Iowa Hill; altitude, 3,225 feet; and from June 1, 1883, to January 1, 1891, at Iowa Hill, Placer County; altitude, 2,825 feet above sea level:

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1879	12.50	12.50	18.25	7.87	3.25	.25				3.50	3.63	13.35	75.10	1879–80	64.58
1880	5.00	6.10	7.88	18.87	6.25					.75	.75	20.80	66.40	1880–81	63.87
1881	20.75	10.50	4.62	3.15	.13	2.12			2.50	4.25	3.90	10.56	62.48	1881–82	57.23
1882	8.92	6.80	10.43	7.59	1.55	.73			.35	8.50	6.63	2.69	54.19	1882–83	48.30
1883	4.37	4.24	10.63	3.67	7.22				.75	4.54	2.02	3.75	41.19	1883–84	64.21
1884	8.05	11.26	16.50	13.22	1.60	2.52			1.60	2.43		24.22	81.40	1884–85	38.02
1885	3.03	1.48	.68	2.93	.05	1.60			1.20		15.82	6.14	32.93	1885–86	55.25
1886	10.89	.68	6.46	12.19	1.87					2.28	.80	5.75	40.92	1886–87	37.68
1887	3.61	15.61	2.23	6.55	.78	.07		.05	.48		.95	6.52	36.85	1887–88	32.00
1888	11.73	2.41	4.59	1.47	1.14	2.60	.06		.35		3.78	8.14	36.27	1888–89	38.36
1889	.58	.71	12.12	4.20	8.26	.22				9.20	8.49	21.04	64.82	1889–90	71.16
1890	20.87	10.74	14.12	3.02	3.48	.08			2.29	2.64		7.34	64.58	1890–91	*12.27

Average seasonal precipitation, 50.06 inches.

* Up to January 1, 1891.

KEELER, INYO COUNTY, CAL.

Annual meteorological review from date of opening station in 1885, to and including the year 1890. By Herbert E. Wilkinson, Observer, Signal Service:

	*1885.	1886.	1887.	1888.	1889.	1890.
Average barometer	26.284	26.306	26.303	26.290	26.29	26.31
Highest barometer	26.729	26.748	26.770	26.870	26.65	26.78
Lowest barometer	25.850	25.709	25.730	25.750	25.72	25.74
Range of barometer	.879	1.039	1.040	1.120	.93	1.04
Average temperature	64.6	60.4	60.8	61.0	62.3	60.3
Highest temperature	104.7	103.4	99.2	99.8	107.0	103.0
Lowest temperature	31.4	24.3	22.0	11.8	21.0	16.0
Range of temperature	73.3	79.1	77.2	88.0	86.0	87.0
Greatest monthly range of temperature	53.1	50.0	56.3	47.5	60.0	55.0
Least monthly range of temperature	31.2	32.2	37.6	26.3	34.0	32.0
Average monthly range of temperature	43.1	42.8	44.6	41.2	43.0	44.0
Average maximum temperature	76.7	72.0	71.8	71.9	73.0	71.4
Average minimum temperature	53.4	49.9	49.1	50.4	51.6	49.3
Average humidity	46.3	42.4	36.9	40.4	39.0	38.2
Average dew point	41.6	34.8	31.1	33.2	34.0	32.3
Prevailing direction of wind	S.W.	S.W.	S.W.	S.	S.	S.S.E.
Total movement of wind	38,820	50,751	55,563	54,545	61,237	58,067
Maximum velocity of wind	45	40	44	42	48	48
Direction of maximum velocity	S.	W.	W.	W.	N.	W.
Total precipitation	2.39	1.94	5.04	5.66	2.00	3.74
Number of cloudless days	236	291	254	227	259	261
Number of partly cloudy days	59	65	91	111	74	78
Number of cloudy days	11	9	20	28	32	26
Number of days with precipitation	22	16	29	35	25	20
Number of days maximum temperature above 90°	70	83	68	69	93	71
Number of days minimum temperature below 32°	1	29	41	27	31	42

* For ten months; station opened March 1, 1885.

Highest, lowest, and mean temperature at Keeler, California:

Month.	1885.	1886.	1887.	1888.	1889.	1890.
January—Highest	--------	67.0	63.5	58.0	59.0	59.0
Lowest	--------	25.6	24.7	11.8	23.0	16.0
Mean	--------	42.8	43.1	35.3	39.0	36.0
February—Highest	--------	73.0	62.7	68.6	72.0	67.0
Lowest	--------	31.2	22.0	30.0	21.0	19.0
Mean	--------	50.8	40.0	47.8	46.9	42.1
March—Highest	73.0	71.0	77.1	72.5	75.0	74.0
Lowest	33.6	26.8	33.0	27.0	36.0	28.0
Mean	54.3	47.5	56.5	50.6	53.6	52.0
April—Highest	77.8	80.3	81.2	85.8	86.0	80.0
Lowest	36.6	35.2	32.2	39.0	40.0	35.0
Mean	57.8	55.6	57.4	63.4	62.4	59.4
May—Highest	95.6	91.4	93.3	87.8	96.0	94.0
Lowest	42.5	45.6	37.0	40.7	36.0	39.0
Mean	68.0	68.4	66.7	66.4	66.8	69.0
June—Highest	94.4	98.4	99.2	96.0	97.0	96.0
Lowest	46.3	48.4	43.6	48.5	63.0	46.0
Mean	69.7	75.8	73.9	73.9	78.9	73.2
July—Highest	104.7	100.4	98.6	98.0	107.0	103.0
L owst	60.7	58.3	61.0	54.1	65.0	66.0
Mean	80.1	79.9	81.1	79.3	83.8	85.0
August—Highest	102.7	103.4	98.8	99.8	101.0	98.0
Lowest	62.2	65.1	53.4	60.0	64.0	59.0
Mean	81.0	81.5	79.7	80.5	82.7	80.1
September—Highest	97.2	94.0	91.6	96.1	97.0	97.0
Lowest	49.7	53.4	53.6	58.7	50.0	50.0
Mean	74.1	74.1	72.3	78.2	74.9	73.2
October—Highest	90.4	81.4	90.7	85.1	91.0	80.0
Lowest	46.8	33.6	45.3	47.0	41.0	38.0
Mean	64.4	58.2	63.4	64.4	61.6	60.4
November—Highest	78.6	68.1	70.0	70.0	71.0	77.0
Lowest	36.2	24.3	28.1	32.4	33.0	33.0
Mean	51.7	45.1	52.2	49.4	50.2	51.2
December—Highest	62.6	62.4	65.6	56.1	62.0	61.0
Lowest	31.4	30.2	23.3	29.8	23.0	29.0
Mean	45.4	44.7	42.9	42.8	44.8	42.5
Annual mean	--------	60.4	60.8	61.0	62.3	60.3

Annual average temperature for five years, 61°.
Station opened March 1, 1885.

The precipitation by months, years, and seasons, at Keeler, Inyo County, California, beginning with March, 1885, and ending with January 31, 1891:

Month.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
January	--------	.49	T.	.70	.04	.42	none
February	--------	.14	.93	1.21	T.	.01	--------
March	.12	.60	.00	.30	.52	T.	--------
April	.82	.40	1.14	.12	.12	.10	--------
May	.00	.00	.04	.30	.06	.20	--------
June	.08	.00	T.	.20	.01	.00	--------
July	.00	.14	.52	.17	.00	T.	--------
August	.11	.08	.00	.10	T.	1.71	--------
September	.00	.00	1.08	.06	.08	.93	--------
October	.25	.01	.84	.00	.56	.03	--------
November	.65	.08	.01	1.68	.05	.12	--------
December	.36	.00	.48	.82	.56	.22	--------
Total annual	--------	1.94	5.04	5.66	2.00	3.74	--------

Total precipitation for each season was as follows:

The season of 1885–86	3.00 inches.
The season of 1886–87	2.42 inches.
The season of 1887–88	5.76 inches.
The season of 1888–89	3.58 inches.
The season of 1889–90	1.98 inches.
The season of 1890–91, to January 1, 1891	2.43 inches.

The average precipitation for the first five seasons, July first of one year to June thirtieth of the next, was 3.35 inches. The average precipitation for the five years (twelve calendar months from January to December), 3.68 inches. This shows Keeler to be quite a dry place, but not so dry as has been supposed.

WEATHER AT GEORGETOWN, EL DORADO COUNTY, CAL.

Weather summary for the year 1890, at Georgetown, El Dorado County, California. By C. M. FITZGERALD, of the California Water and Mining Company:

MONTH.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Clear Days	Fair Days	Cloudy Days	Rainy Days
January	39.4	27.6	33.5	50.0	18.0	19.90	11	5	15	16
February	47.9	32.8	40.3	63.4	18.0	8.96	12	4	12	11
March	53.6	37.3	47.0	65.0	29.0	14.70	12	3	16	16
April	65.1	43.4	54.2	78.0	34.0	3.86	21	3	6	6
May	69.3	49.4	59.3	89.3	38.0	4.66	20	4	7	6
June	76.0	50.8	63.4	89.0	38.0	.10	30	----	----	----
July	89.0	60.4	74.7	98.4	52.0	----	31	----	----	----
August	85.9	59.9	72.9	93.8	49.4	----	31	----	----	----
September	81.0	57.4	69.2	88.6	49.5	3.00	22	5	3	4
October	70.7	48.5	59.6	82.0	37.5	----	28	3	----	----
November	67.1	44.9	56.0	77.2	32.0	----	26	4	----	----
December	55.6	39.2	47.4	65.5	29.0	7.65	18	3	10	6
For the year	66.7	45.9	56.4	78.3	35.3	62.83	262	34	69	66

First killing frost on seventh of November, 1890.

RAINFALL AT GEORGETOWN, EL DORADO COUNTY, CAL.

The rainfall at Georgetown, El Dorado County, was furnished by C. M. Fitzgerald, of the California Water and Mining Company, and extends from November, 1872, to date:

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for year.	Season of.	Total for Season.
1872	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	4.30	18.72	--------	--------	--------
1873	4.08	13.05	3.05	3.11	.12	none	.03	none	none	.61	.55	16.60	41.20	1873–74	63.67
1874	16.66	8.03	13.87	5.80	1.32	.20	none	none	none	3.86	14.60	1.24	65.58	1874–75	46.31
1875	17.87	.04	5.07	.31	2.03	2.06	none	none	none	1.90	24.12	10.85	64.25	1875–76	81.24
1876	13.09	9.97	14.54	4.78	1.22	none	.77	none	none	11.47	.80	none	56.64	1876–77	41.25
1877	12.44	2.14	7.78	1.74	3.87	.24	none	none	none	1.03	4.30	1.97	35.51	1877–78	61.31
1878	16.21	22.78	10.92	2.99	.99	.12	none	none	.66	2.56	2.66	.48	60.37	1878–79	60.96
1879	11.24	12.41	17.57	9.65	3.39	.34	none	none	none	3.85	6.25	11.73	76.43	1879–80	70.40
1880	5.47	6.00	5.50	25.63	5.97	none	none	none	none	.18	.37	22.67	71.79	1880–81	65.82
1881	20.83	12.85	3.84	2.40	.40	2.28	none	none	2.02	4.23	3.30	10.32	62.47	1881–82	54.13
1882	8.59	5.88	10.44	7.11	2.06	.18	none	none	.16	7.75	7.00	3.31	52.48	1882–83	45.94
1883	4.70	3.08	8.73	3.87	7.34	none	none	none	1.60	4.10	1.94	3.50	38.86	1883–84	72.65
1884	7.53	13.80	19.94	15.07	1.52	3.65	none	.01	.80	3.54	.03	33.73	99.62	1884–85	49.99
1885	4.37	.82	.24	3.98	.19	2.28	.03	none	1.16	none	20.77	7.03	40.87	1885–86	73.08
1886	18.32	1.16	7.75	15.04	1.76	.06	none	none	none	3.43	1.79	6.90	56.21	1886–87	42.12
1887	3.36	15.79	2.40	6.54	.93	.18	none	none	.53	none	1.44	7.66	38.83	1887–88	33.51
1888	12.59	2.79	5.47	1.05	.38	1.56	.04	none	.41	none	4.67	7.99	36.95	1888–89	33.47
1889	.66	.68	12.29	2.77	7.07	.25	none	none	none	10.45	9.70	22.94	66.81	1889–90	95.27
1890	19.90	8.96	14.70	3.86	4.66	.10	none	none	3.00	none	none	7.65	62.83	1890–91	*10.65

Average seasonal precipitation for seventeen years, 58.30 inches. It will be seen that a large amount of rain and melted snow was measured during that memorably wet season of 1889–90—more than was ever known since records were kept by the Observer at Georgetown.

* Up to January 1, 1891.

RAINFALL AT PLACERVILLE, EL DORADO COUNTY, CAL.

The rainfall record at Placerville, El Dorado County, from October, 1879, to December, 1887, was furnished by SAMUEL HALE, Superintendent of the El Dorado Water and Deep Gravel Mining Company, after which time, by Mr. RICHARD ROWLAND, Superintendent. Records were also kept from February, 1874, to February, 1877. The total for those years was, for eleven months in 1874, 33.23 inches; 1875, 44.84 inches; 1876, 39.21 inches; January and February, 1877, gave 11.05 inches.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1879	--------	--------	--------	--------	--------	--------	--------	--------	--------	3.47	5.28	7.53	--------	1879–80	52.60
1880	4.38	5.81	4.66	17.52	3.95	none	none	none	none	.35	.58	16.94	54.19	1880–81	48.04
1881	15.53	7.01	3.38	2.36	sprin.	1.89	sprin.	none	1.08	2.80	2.87	7.70	44.62	1881–82	42.46
1882	6.71	5.15	9.30	5.53	1.19	.13	sprin.	none	.93	5.72	4.94	1.98	41.58	1882–83	36.56
1883	3.74	2.58	6.88	3.54	6.25	none	sprin.	none	1.67	3.38	1.67	2.63	32.34	1883–84	57.36
1884	6.06	11.56	14.46	11.82	1.60	2.51	sprin.	.03	.85	2.47	.10	22.65	74.11	1884–85	36.56
1885	4.15	.97	.33	3.32	.27	1.42	none	none	.55	none	15.97	5.22	32.20	1885–86	54.63
1886	13.03	1.15	5.22	11.75	1.24	.50	sprin.	none	none	1.42	.91	5.02	40.24	1886–87	33.32
1887	3.18	14.18	2.09	5.71	.53	.28	none	none	.58	.06	1.42	8.34	36.37	1887–88	31.83
1888	11.27	2.39	5.26	.91	1.10	.50	.04	sprin.	.88	sprin.	5.98	7.06	35.39	1888–89	35.77
1889	1.03	.86	9.78	1.93	8.05	.16	none	sprin.	none	9.07	7.77	18.18	56.83	1889–90	63.77
1890	14.57	7.46	13.41	3.51	3.61	none	none	sprin.	1.64	sprin.	sprin.	6.89	51.09	1890–91	* 8.53

The average seasonal rainfall for eleven years is 44.81 inches.

* Up to January 1, 1891.

WEATHER AT PLACERVILLE, EL DORADO COUNTY, CAL.

Weather summary for the year 1890 at Placerville, situated well up in the foothills. Richard Rowland, Observer:

Month.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Clear Days	Fair Days	Cloudy Days
January	46.4	28.7	40.1	57	14	14.57	6	2	23
February	52.9	31.5	43.0	68	16	7.46	9	5	14
March	59.5	37.1	49.2	68	26	13.41	6	4	21
April	65.9	42.8	56.5	77	33	3.51	14	8	8
May	71.7	48.1	64.1	91	36	3.61½	15	2	14
June	77.6	47.2	67.0	93	38	....	23	......	7
July	87.7	52.3	73.6	98	46	....	29	2	......
August	86.2	49.8	72.4	94	46	sprin.	23	6	2
September	81.6	51.5	68.1	91	45	1.64	15	6	9
October	67.0	41.1	55.7	79	33	sprin.	22	6	3
November	63.4	33.5	48.5	73	27	sprin.	21	5	4
December	52.5	32.6	43.2	61	26	6.89	16	3	12
For the year	67.7	41.4	56.8	* 98	† 14	51.90	199	49	117

Mean of the maximum and minimum temperature for the year, 54.6°.

* In July. † In January.

LODI, SAN JOAQUIN COUNTY, CAL.

Weather summary for the year 1890, at Lodi, California. By Ezra Fiske, Observer:

Month.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation
January	48.90	35.74	42.94	60	26	6.67
February	56.46	39.35	48.46	71	28	2.90
March	62.83	43.61	54.12	75	33	2.71
April	71.03	45.66	58.82	81	37	1.94
May	76.71	51.87	64.45	95	43	1.20
June	81.30	51.60	67.04	92	44	.00
July	88.96	55.38	73.44	103	49	.00
August	85.96	56.06	72.42	96	50	.00
September	82.63	54.36	70.09	92	50	.99
October	76.19	47.00	64.04	84	41	.00
November	67.83	36.90	55.11	80	33	.00
December	49.19	40.64	45.31	61	32	3.65
For the year	70.75	46.51	58.85	* 103	† 26	20.6

Yearly mean for a great number of years, 59.69°.

* In July. † In January.

The following table shows the amount of rainfall at Lodi, as furnished by J. D. Huffman, Observer:

Month.	1887.	1888.	1889.	1890.
January	....	5.09	.35	6.67
February	....	.44	.65	2.90
March	....	2.59	5.07	2.71
April	....	.11	.20	1.94
May	....	.61	2.57	1.20
June	....	.43	.11	none
July	....	none	none	none
August	....	none	none	none
September	....	.88	none	.99
October	none	none	5.62	none
November	.77	3.61	4.71	none
December	4.54	3.56	7.70	3.65
Total for twelve months	....	17.32	26.98	20.06

Total for season of 1887–88, 14.58 inches; 1888–89, 17 inches; 1889–90, 33.45 inches; and for season of 1890–91, up to January 1, 1891, 4.64 inches.

VACAVILLE, SOLANO COUNTY, CAL.

Weather summary for the year 1890, at Vacaville, Solano County, Cal. By G. O. Coburn, Observer:

Month.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Rainy Days
January	49.2	37.5	43.3	59	30	12.37	20
February	55.5	41.9	48.0	70	31	5.71	10
March	60.9	47.3	52.7	72	38	5.98	14
April	69.1	53.5	58.7	83	46	1.23	6
May	71.5	61.4	66.9	98	50	1.63	5
June	83.7	64.3	71.6	97	55	none	none
July	92.0	68.7	78.5	105	62	none	none
August	89.5	66.6	75.8	99	59	trace	1
September	86.6	62.1	72.5	100	56	0.34	6
October	80.8	55.1	66.4	89	46	trace	1
November	72.6	46.0	57.6	83	38	trace	1
December	50.7	40.0	61.2	68	32	4.22	10
For the year	74.84	53.78	61.2	85.25	45.25	31.48	73

RAINFALL AT VACAVILLE, SOLANO COUNTY, CAL.

Furnished by Mr. A. V. Stevenson, and shows a record of rainfall by months, years, and seasons, from 1880 to date:

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1880	3.48	2.28	2.73	8.26	7.58	1.78	none	none	none	none	.07	21.25	47.43	1879–80	36.81
1881	15.61	4.58	1.13	2.36	none	none	none	none	none	.28	1.93	5.36	31.25	1880–81	45.00
1882	2.76	3.38	4.17	2.37	.19	none	none	none	1.10	3.11	3.77	1.15	22.00	1881–82	20.44
1883	2.45	2.11	6.26	2.03	5.63	none	none	none	none	2.24	.49	1.63	22.84	1882–83	27.61
1884	6.02	7.19	11.45	7.48	.24	none	none	none	.41	1.20	none	16.18	50.17	1883–84	36.74
1885	1.89	.28	.28	1.54	none	none	none	none	none	.30	15.98	5.68	25.95	1884–85	21.78
1886	8.74	.17	1.32	4.84	.05	none	none	none	none	.27	.14	2.26	17.79	1885–86	37.08
1887	1.34	9.40	1.06	2.65	none	none	nene	none	.16	none	1.01	5.62	21.24	1886–87	17.12
1888	6.34	.45	4.21	.08	.04	.11	none	none	.71	none	5.77	5.35	23.06	1887–88	18.02
1889	.44	.98	7.92	.80	3.04	.15	none	none	none	7.98	4.26	12.48	38.05	1888–89	25.16
1890	11.74	5.49	5.74	.96	1.40	none	none	trace	.28	.04	none	2.92	28.57	1889–90	53.29
1891														1890–91	*4.56

* Up to January 1, 1891.

NAPA CITY, CAL.

Weather summary for the year 1890, at Napa City. By W. H. Martin, Observer:

Month.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Clear Days	Fair Days	Cloudy Days	Rainy Days	Prevailing Wind—Direction
January	44.87	34.00	39.43	53.0	26	9.40	8	8	15	21	S.E.
February	50.82	36.78	43.80	60.0	30	6.36	6	14	8	10	S.
March	55.45	42.38	48.91	64.0	32	5.46	10	7	14	15	S.
April	62.70	45.16	53.93	76.0	38	1.68	8	12	10	5	S.
May	69.48	50.35	59.91	91.0	42	2.23	14	11	6	4	S.
June	73.60	50.86	62.23	85.0	41	.00	21	9	0	0	S.
July	75.77	52.07	63.92	87.5	46	.00	24	7	0	0	S.
August	73.87	52.39	63.13	86.0	47	T.	24	7	0	0	S.
September	71.67	50.53	61.10	80.0	44	.43	19	4	7	3	S.
October	70.00	46.74	58.37	79.0	38	.00	24	7	0	0	S.
November	63.00	40.33	51.66	72.0	34	.00	14	15	1	0	N.
December	47.55	34.51	41.03	56.0	30	4.13	2	22	7	6	S. & N.
For the year	63.23	44.78	53.95	*91.0	†26	29.69	174	123	68	64	S.

* In May. † In January.

RAINFALL AT FORT ROSS, SONOMA COUNTY, CAL.

The following table of rainfall was furnished by OSCAR CALL, and shows a record of rainfall by months, years, and seasons, from July, 1874, to date:

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1874	--------	--------	--------	--------	--------	--------	none	none	none	3.00	31.54	.40	--- ---	1874–75	50.54
1875	9.15	.69	3.41	none	.45	1.90	none	.13	none	2.57	12.15	6.33	36.93	1875–76	58.28
1876	9.75	9.31	14.44	2.21	1.16	.23	.06	.08	.71	9.32	.90	.15	46.32	1876–77	31.42
1877	9.00	5.49	3.95	.18	.80	.78	.20	none	none	2.18	5.33	5.22	33.23	1877–78	92.86
1878	33.29	29.65	13.85	3.14	none	none	none	none	2.09	2.79	2.05	1.31	88.17	1878–79	52.84
1879	7.78	11.33	18.43	5.02	2.04	none	none	.10	none	1.73	15.82	15.47	77.72	1879–80	67.27
1880	6.85	3.53	4.05	16.59	3.13	none	none	none	none	.24	none	23.38	57.77	1880–81	65.74
1881	19.99	13.88	2.97	2.51	.94	1.83	none	none	.75	3.10	.93	13.06	69.96	1881–82	44.20
1882	6.56	11.78	3.01	4.04	.84	.13	none	none	.57	8.64	5.39	3.49	44.45	1882–83	45.48
1883	6.57	1.40	9.67	3.25	6.50	none	none	none	2.00	2.32	.49	1.38	33.58	1883–84	48.54
1884	7.16	7.44	10.76	11.79	.80	4.40	none	none	.80	1.85	1.85	19.17	66.02	1884–85	36.53
1885	5.31	3.58	1.45	2.19	none	.33	none	none	.55	1.14	18.92	5.98	39.45	1885–86	56.00
1886	14.62	.25	3.56	8.94	2.04	none	none	none	none	1.86	.26	8.12	40.65	1886–87	27.69
1887	2.61	8.35	1.72	3.48	.17	.12	none	none	.60	none	2.45	4.11	23.61	1887–88	28.50
1888	10.79	2.55	4.61	none	.90	2.49	.22	none	.58	none	4.95	7.71	34.80	1888–89	29.46
1889	.97	1.77	8.35	1.54	3.17	.20	none	none	.12	10.92	4.02	13.07	44.13	1889–90	59.07
1890	12.44	3.75	9.87	3.44	1.51	.13	none	none	.19	.10	none	6.21	37.64	1890–91	*6.50

Average seasonal rainfall for sixteen years is 49.65 inches.

* Up to January 1, 1891.

SONOMA, SONOMA COUNTY, CAL.

The following summary of the weather for the season of 1889–90, at Sonoma, Sonoma County, California, was furnished by ROBERT HALL:

MONTH.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Clear Days	Fair Days	Cloudy Days	Rainy Days	Prevailing Wind—Direction
1889—October	75	50	62	82	42	9.09	12	4	6	9	S.S.E.
November	58	46	52	78	35	4.36	11	5	6	8	S.E.
December	55	36	46	62	31	11.69	4	1	4	22	S. S.E.
1890—January	55	45	50	62	29	12.87	2	5	5	19	S.W.
February	61	37	49	74	25	6.02	10	6	5	7	S.S.E.
March	63	42	52	71	36	6.16	7	7	6	11	to S.W. S.W.
April	65	47	56	82	49	1.80	11	10	4	5	W.
May	67	51	59	94	47	1.12	17	3	7	4	W. to
June	75	52	64	88	47	....	22	8	0	0	S.W. S.W.
July	81	51	66	93	48	....	22	9	0	0	S.W.
August	77	54	66	90	44	....	12	18	1	0	W. to
September	82	50	66	92	43	....	21	3	6	0	S.W.
For the season	67.8	46.8	57.3	*94	†25	53.11	151	79	50	85	S.W.

There were eight light frosts in February, and one in December, 1889.

*In May. †In February.

RAINFALL AT SONOMA, CAL.

The following is a summary of the rainfall at Sonoma, by seasons:

Month.	Inches.	Month.	Inches.
1885—November	13.40	1888—June	.73
December	4.46	July	.01
1886—January	7.84		
February	.28	Total	20.68
March	1.38		
April	7.09	1888—September	.86
		October	.00
Total	34.45	November	5.02
		December	8.30
1886—October	.95	1889—January	.90
November	.27	February	.79
December	2.36	March	8.84
1887—January	1.94	April	.68
February	11.77	May	2.68
March	.93	June	.13
April	2.53		
		Total	28.20
Total	20.75		
		1889—October	9.09
1887—September	.25	November	4.36
October	.00	December	11.69
November	2.08	1890—January	12.87
December	4.97	February	6.02
1888—January	5.78	March	6.16
February	.70	April	1.80
March	4.55	May	1.12
April	.19		
May	1.42	Total	53.11

The average precipitation for the five seasons since 1885–86 is 31.44 inches.

RAINFALL AT SAN FRANCISCO, CAL.

The rainfall from 1849 to date, from THOMAS TENNENT's and SIGNAL OFFICE records:

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1849	------	------	------	------	------	------	none	none	none	3.14	8.66	6.20	------	1849–50	33.10
1850	8.34	1.77	4.53	.46	none	none	none	none	.33	none	.92	1.05	17.40	1850–51	7.40
1851	.72	.54	1.94	1.23	.67	none	none	none	1.03	.21	2.12	7.10	15.56	1851–52	18.44
1852	.58	.14	6.68	.26	.32	none	none	none	none	.80	5.31	13.20	27.29	1852–53	35.23
1853	3.92	1.42	4.86	5.37	.35	none	none	.04	.46	.12	2.28	2.32	21.14	1853–54	23.87
1854	3.88	8.04	3.51	3.12	.02	.08	none	.01	.15	2.41	.34	.81	22.37	1854–55	23.68
1855	3.67	4.77	4.64	5.00	1.88	none	none	none	none	none	.67	5.76	26.39	1855–56	21.66
1856	9.40	.50	1.60	2.94	.76	.03	.02	none	.07	.45	2.79	3.75	22.31	1856–57	19.88
1857	2.45	8.59	1.62	none	.02	.12	none	.05	none	.93	3.01	4.14	20.93	1857–58	21.81
1858	4.36	1.83	5.55	1.55	.34	.05	.05	.16	none	2.74	.69	6.14	23.46	1858–59	22.22
1859	1.28	6.32	3.02	.27	1.55	none	none	.02	.03	.05	7.28	1.57	21.39	1859–60	22.27
1860	1.64	1.60	3.99	3.14	2.86	.09	.21	none	none	.19	.58	6.16	20.46	1860–61	19.00
1861	2.47	3.72	4.08	.51	1.00	.08	none	none	.02	none	4.10	9.54	25.52	1861–62	49.27
1862	24.36	7.53	2.20	.73	.74	.05	none	none	none	.40	.15	2.35	38.51	1862–63	13.08
1863	3.63	3.19	2.06	1.04	.26	none	none	none	.03	none	2.55	1.80	14.56	1863–64	10.08
1864	1.83	none	1.52	1.57	.78	none	none	.21	.01	.13	6.68	8.91	21.64	1864–65	24.73
1865	5.14	1.34	.74	.94	.63	none	none	none	.24	.26	4.19	.58	14.06	1865–66	22.93
1866	10.88	2.12	3.04	.12	1.46	.04	none	none	.11	none	3.35	15.16	36.28	1866–67	34.92
1867	5.16	7.20	1.58	2.36	none	none	none	none	.04	.20	3.41	10.69	30.64	1867–68	38.84
1868	9.50	6.13	6.30	2.31	.03	.23	none	none	none	.15	1.18	4.34	30.17	1868–69	21.35
1869	6.35	3.90	3.14	2.19	.08	.02	none	none	.12	1.29	1.19	4.31	22.59	1869–70	19.31
1870	3.89	4.78	2.00	1.53	.20	none	none	none	.03	none	.43	3.38	16.24	1870–71	14.10
1871	3.07	3.76	1.29	1.93	.21	none	none	none	.03	.11	3.72	16.74	30.86	1871–72	34.71
1872	4.22	6.97	1.64	1.10	.16	.02	none	none	.14	.21	2.62	7.25	24.33	1872–73	18.02
1873	2.17	4.24	.78	.52	.01	.08	.03	.15	none	.68	1.31	10.12	20.09	1873–74	23.98
1874	4.85	1.83	3.55	1.04	.34	.08	none	none	.83	2.73	5.92	.28	21.46	1874–75	19.15
1875	6.97	.20	1.08	.02	.11	1.01	none	none	none	.24	7.27	4.15	21.05	1875–76	31.19
1876	7.55	4.92	5.49	1.29	.24	.04	.01	.01	.38	3.36	.25	none	23.54	1876–77	11.04
1877	4.32	1.18	1.08	.20	.18	.91	.02	none	none	.65	1.57	2.66	11.93	1877–78	35.18
1878	11.97	12.52	4.56	1.06	.16	.01	.01	none	.55	1.27	.57	.58	33.26	1878–79	24.44
1879	3.52	4.90	8.75	1.89	2.35	.05	.01	.02	sprin.	.78	4.03	4.46	30.76	1879–80	26.66
1880	2.23	1.87	2.08	10.06	1.12	none	none	none	none	.05	.33	12.33	30.07	1880–81	29.85
1881	8.69	4.64	.90	2.00	.22	.69	none	none	.25	.54	1.94	3.85	23.72	1881–82	16.14
1882	1.68	2.96	3.45	1.22	.21	.04	none	none	.26	2.66	4.18	2.01	18.67	1882–83	20.12
1883	1.92	1.04	3.01	1.51	3.52	.01	none	none	.42	1.48	1.60	.92	15.43	1883–84	32.38
1884	3.94	6.65	8.24	6.33	.23	2.57	sprin.	.04	.33	2.55	.26	7.68	38.82	1884–85	8.10

1885	2.53	.30	1.01	3.17	.04	.19	.06	sprin.	.11	.72	11.78	4.99	24.90	1885–86	33.05
1886	7.42	.24	2.07	5.28	.37	.01	.23	sprin.	.01	1.48	.84	2.07	20.02	1886–87	19.04
1887	1.90	9.24	.84	2.30	.06	.07	sprin.	.01	.29	sprin.	.99	3.34	19.04	1887–88	16.74
1888	6.81	.94	3.60	.11	.38	.27	.01	.01	.98	.13	3.99	5.80	23.03	1888–89	23.86
1889	1.28	.72	7.78	.96	2.17	.03	.01	sprin.	sprin.	7.28	2.90	13.81	36.95	1889–90	45.85
1890	9.61	5.16	4.73	1.18	1.07	.10	.02	none	.31	none	none	3.25	25.43	1890–91	*3.58

* Up to January 1, 1891.

SAN FRANCISCO'S ANNUAL METEOROLOGICAL REVIEW.

Showing the climatic condition in all its features for thirteen years, from 1878 to 1889, both years inclusive. Compiled by George H. Willson, Observer in charge of the local Signal Station; barometer readings corrected for elevation and temperature:

Annual Weather Review for Year:	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
Average barometer	29.976	30.033	30.047	30.044	30.060	30.054	30.001	30.028	30.041	30.038	30.016	30.00	30.93
Highest barometer	30.43	30.59	30.49	30.41	30.49	30.67	30.54	30.45	30.40	30.56	30.57	30.37	30.46
Lowest barometer	29.43	29.29	29.48	29.67	29.74	29.63	29.43	29.42	29.32	29.53	29.47	29.32	29.43
Range of barometer	1.00	1.30	1.01	.74	.75	.94	1.11	1.03	1.08	1.03	1.10	1.05	1.03
Average temperature	56.6	56.1	54.2	55.8	54.4	54.7	55.7	56.9	56.1	55.2	55.5	57.9	56.3
Highest temperature	78.0	89.0	83.5	83.0	83.0	95.2	83.0	87.0	93.9	96.9	93.4	89.0	86.0
Lowest temperature	39.0	34.0	37.0	40.0	34.5	35.0	35.0	43.0	41.0	33.1	28.7	39.0	36.0
Range of temperature	39.0	55.0	46.5	43.0	48.5	60.2	48.0	44.0	52.9	63.8	64.7	50.0	50.0
Greatest range of temperature	30.0	36.0	38.5	36.0	33.0	44.2	36.0	35.0	43.8	51.3	42.4	40.0	38.0
Least monthly range of temperature	20.0	20.0	19.0	18.0	19.0	20.0	15.5	17.5	22.7	20.9	21.6	23.0	21.0
Average maximum temperature	71.0	75.5	71.8	72.0	70.0	75.4	71.5	73.7	77.9	78.8	63.9	78.0	66.2
Average minimum temperature	47.2	46.0	44.6	46.6	44.7	45.3	47.2	49.2	45.5	44.7	50.7	47.0	49.4
Average monthly range of temp.	23.8	29.5	27.2	25.4	25.2	30.1	24.3	24.5	32.4	34.1	13.2	31.0	13.8
Average humidity	72.9	73.9	75.6	75.8	75.0	78.1	79.5	81.0	75.1	75.4	78.5	78.0	77.4
Average dew point	....	....	....	....	....	47.5	49.1	50.7	47.5	46.8	48.2	49.0	46.5
Prevailing direction of wind	S.W.	W.	W.	W.	W.	W.	W.	W.	W.	W.	W.	S.W.	W.
Total precipitation	32.26	30.76	30.07	23.73	18.67	15.43	38.82	24.90	20.02	19.04	23.03	36.94	25.43
Total movement of wind	79,387	78,575	82,724	83,105	85,554	81,480	78,557	79,194	78,237	80,457	76,469	74,830	73,681
Maximum velocity of wind	40	40	44	36	36	36	45	36	42	36	40	36	36
Direction of maximum velocity	N.	N.E.	N.	W.	N.W.	W.	N.	W.	S.E.	W.	N.W.	S.W.	S.,S.W.,W.
Clear days	146	159	153	150	156	132	124	116	165	152	117	100	148
Fair days	142	146	110	126	144	152	148	157	134	140	155	185	146
Cloudy days	77	60	103	89	65	77	93	92	65	73	94	80	71
Days of precipitation	75	85	70	65	73	51	83	70	64	60	76	96	71
Snow storms	....	....	....	....	1	0	1	0	0	1	1	0	0
Thunder and lightning	1	0	0	2	4	2	3	2	1	1	9	3	5
Days temperature above 90°	0	0	0	0	0	3	0	0	2	1	1	0	0
Days temperature below 32°	0	0	0	0	0	0	0	0	0	0	3	0	0

SANTA CLARA, CAL.

Weather summary for the year 1890 at Santa Clara, Cal. By A. Block, Observer:

Month.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Rainy Days	Light Frosts
January	52.0	39.0	46.0	62.0	29.0	18	12
February	55.0	43.0	52.0	68.0	32.0	10	4
March	61.0	46.0	53.5	72.0	31.0	9	3
April	64.0	48.5	56.0	79.0	41.0	6	
May	71.0	53.75	61.5	89.0	41.0	3	
June	72.0	53.5	61.0	87.0	42.0		
July	76.0	54.5	64.5	88.0	46.0		
August	77.0	56.5	65.5	87.0	47.0		
September	71.0	55.5	63.0	86.0	44.0	2	
October	74.0	48.0	61.0	84.0	39.0		
November	67.5	43.0	54.75	75.0	36.0	1	7
December	55.0	40.0	47.5	62.0	33.0	6	16
For the year	66.3	48.4	57.2	78.25	38.5	55	42

LOS GATOS, CAL.

Weather summary for the year 1890 at Los Gatos, California. By F. H. McCullagh, Observer:

Month.	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation
January	44.2	60	27	16.45
February	48.4	70	30	7.83
March	53.2	74	35	5.27
April	56.8	82	38	1.25
May	63.5	94	42	1.30
June	63.5	93	40	
July	67.8	97	44	
August	67.7	93	45	
September	65.6	91	44	.19
October	61.6	85	41	
November	55.5	77	36	.03
December	46.6	62	33	4.74
For the season	57.9	*97	†27	37.06

* In July. † In January.

NORTH HILL VINEYARD, MILTON, CALAVERAS COUNTY, CAL.

Altitude, six hundred and fifty feet; latitude, 38° 6′ north; longitude, 120° 50′ west. Prepared and furnished by EDWARD WESSON, Observer:

1890.	Temperature.				Rain.	
	Max.	Min.	Max. Daily Range.	Mean.	Rainy Days.	Rainf'll, Inches.
January	55	28	14	42.4	14	5.74
February	67	29	14	47.6	9	2.33
March	69	39	20	53.1	12	2.29
April	80	44	23	59.3	4	1.33
May	96	47	22	67.7	4	2.43
June	95	52	28	73.5	none	none
July	104	57	29	81.8	none	none
August	98	59	29	77.7	none	none
September	....	....	....	....	....	.50
October	82	46	25	65.5	none	none
November	78	43	22	58.6	none	none
December	56	32	14	45.1	5	2.62
For the year	....	....	....	62.1	....	17.24

Mean temperature in 1888	63.0
Mean temperature in 1889	62.5
Mean temperature in 1890	62.1
Mean average for three years	62.5

Monthly Notes for 1890 at the North Hill Vineyard, Milton, Calaveras County, Cal.

February 28th, pruning vines ended; began in mid-December, 1889; much hindered by rain and mud.

March 4th, apricots in blossom; 14th, *Riparia* (wild vine) in leaf; 19th, figs in leaf; 27th, first muscat in leaf.

April 2d to 25th, plowing and poling vineyard; no chance for this sooner, owing to sodden ground; 3d to 28th, grafting muscats to riparia stocks; 24th, first sulphuring; 29th, suckering began.

May 10th, last rain of the season, with thunder, lightning, and destructive hail; 12th, second sulphuring; 14th, muscats in blossom; 30th, end of suckering.

June—First crop of muscats had begun to set by beginning of June; 9th to 27th, first irrigation; 16th, second crop of muscats in bloom; 25th, second crop beginning to set; 28th, sun scald is now obvious.

July 14th to August 1st, second irrigation.

August 1st, muscats ripe for eating; 23d, first sale of muscats; 7th to 30th, third irrigation to advance second crop; it deferred maturing of first crop; was probably continued too late.

September 1st to 15th, picking first crop; 22d, began taking up raisins of first crop; 28th, 29th, and 30th, rain.

October 3d to 11th, picking second crop; 24th, last raisins of first crop taken up; 24th to November 6th, finished picking second crop.

November, drying raisins continued in the open air to the end of the month.

December 10th, pruning vines.

FRESNO, CAL.

A brief summary of the weather at Fresno. Furnished by J. R. WILLIAMS, the Signal Service Observer:

1890:	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	For the Year.
Mean temperature	42	47	55	61	69	73	82	81	75	64	57	44	63
Highest temperature	58	70	77	92	103	104	111	105	103	88	82	70	111
Lowest temperature	24	28	33	36	42	46	56	56	53	42	37	28	24
Monthly range	34	42	44	56	61	58	55	49	50	46	45	42	87
Days temperature below 32°	9	3	0	0	0	0	0	0	0	0	0	4	16
Days temperature above 90°	0	0	0	1	9	14	30	30	18	0	0	0	102
Mean dew point	36	38	43	44	48	42	41	48	48	43	37	41	42
Mean humidity	82	73	68	60	55	42	30	38	48	51	55	93	58
Total precipitation	2.12	.80	1.04	.17	.45	0	0	trace	1.26	0	.22	2.30	8.36
Total wind velocity	4,003	3,466	4,190	4,456	5,335	6,067	5,558	5,019	3,706	3,349	2,282	2,561	49,992
Highest wind velocity	23	26	24	20	22	22	22	22	24	24	22	18	26
Direction at time of highest velocity	N.W.	E.	N.W.	N.W.	N.W.	W.	W.	N.W.	N.	N.W.	W.	S.E.	E.
Prevailing wind direction	E.	E.	N.W.	N.W.	N.W.	W.	N.W.	N.W.	N.W.	N.W.	W.	S.	N.W.
Clear days	6	6	9	17	19	26	30	26	20	28	24	1	212
Fair days	13	13	10	9	6	4	1	4	6	3	4	6	79
Cloudy days	12	9	12	4	6	0	0	1	4	0	2	24	74
Rainy days	11	7	6	2	3	0	0	0	5	0	1	5	40
Thunder storms	0	0	0	0	0	0	0	0	2	0	0	0	2

VISALIA, CAL.

The climatic features and peculiarities of Visalia, by Captain L. V. Nanscawen, will be found described as follows for the year 1890:

As a general thing figures are considered dull and uninteresting, but that cannot be said when they are used in recording the climatic conditions occurring in Visalia. All residents of this county are interested in the climate of the county. An idea prevails in some quarters that our summers are torrid and that the heat is unbearable. It must be understood in this connection that while our thermometer climbs up high, still there is at least 15 per cent less humidity in the atmosphere of this county than in the East. Then, as an illustration, when the temperature is 85° here the corresponding temperature in less favored States would be 100°, because the atmosphere in California is drier.

A record of the temperature twice a day is made, at 7 o'clock in the morning and at 3 o'clock in the afternoon. The statistics below are based on the temperature taken at 3 o'clock in the afternoon. The average temperature for the year 1890 was 71.25°. During the past summer August was the warmest month, the average temperature (at 3 o'clock P. M.) being 94°. The coldest month was last January, when the average temperature was 49°. The hottest day of the past year was July 25th, when the mercury rose to 104°. The coldest day was on January 21st, when the mercury dropped to 40°.

Following are the average, maximum, and minimum temperature, by months:

January.—Average temperature, 49°; maximum, 58°, on the 17th and 29th; minimum, 40°, on the 21st.

February.—Average temperature, 56°; maximum, 65°, on the 3d and 4th; minimum, 46°, on the 17th.

March.—Average temperature, 46°; maximum, 51°, on the 9th.

April.—Average temperature, 72°; maximum, 86°, on the 28th; minimum, 64°, on the 18th and 19th.

May.—Average temperature, 81°; maximum, 98°, on the 25th; minimum, 70°, on the 8th, 11th, and 28th.

June.—Average temperature, 87°; maximum, 97°, on the 7th, 28th, and 30th; minimum, 74°, on the 1st and 2d.

July.—Average temperature, 76°; maximum, 104°, on the 25th; minimum, 89°, on the 8th and 9th.

August.—Average temperature, 94°; maximum, 101°, on the 5th; minimum, 86°, on the 30th.

September.—Average temperature, 88°; maximum, 94°, on the 7th; minimum, 70°, on the 27th.

October.—Average temperature, 75°; maximum, 82°, on the 26th; minimum, 65°, on the 9th and 10th.

November.—Average temperature, 64°; maximum, 77°, on the 1st; minimum, 52°, on the 6th.

December.—Average temperature, 50°; maximum, 59°, on the 4th, 18th, and 19th; minimum, 41°, on the 10th.

In the table below will be found the rainfall for the past three years. Last year's rainfall amounted to 9.87 inches. The rainy season commences in the fall, and ends in the spring. The rainfall for the season so far is 3.98 inches. The rainfall last season (fall of 1889 and spring

of 1890) amounted to 14.22 inches, an unusual record. The rainfall for the season before (fall of 1888 and spring of 1889) amounted to only 10.67 inches.

It was during last season, in January, that Visalia experienced a flood. On Friday, January twelfth, rain began to fall, with a low temperature for the season. By morning .10 of an inch had fallen, and by evening of Saturday an additional 1.31 inches were added, and still raining, with a warm atmosphere. It now became evident that high water would follow, and preparations began to be made for a flood. During Saturday night .23 of an inch was reported, which made the total for storm of 1.64 inches, which fell upon an immense body of snow on the mountains and foothills. The next day nearly the entire city was covered with water, and was quite deep in places. In the evening the flood subsided as quickly as it came. Had the weather been warmer the result would have equaled the flood of 1867.

Following is the table of rainfall for the past three years:

Month.	1888.	1889.	1890.
January	3.06	.70	3.34
February	.16	.36	1.12
March	1.61	3.46	1.10
April	.14	.49	.25
May	--------	1.22	.46
September	.35	trace	.73
October	--------	4.08	--------
November	2.39	.66	.51
December	1.70	3.21	2.36
Total	9.41	14.18	9.87

Rainfall for season of 1888–89 was 10.67 inches; 1889–90, 14.22 inches.

SANTA MARIA, CAL.

Weather summary for the year 1890, at Santa Maria, Cal. By L. E. Blochman, Observer:

Month.	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Clear Days	Fair Days	Cloudy Days*	Rainy Days*	Light Frosts	Killing Frosts	Prevailing Wind—Direction
January	46.6	66	28	3.71	7	10	14	12	12	4	S. E.
February	51.4	76	30	3.64	6	10	12	8	6	3	W.
March	54.5	76	34	.88	9	8	14	7	3	none	W.
April	57.3	83	37	.10	7	12	11	2	none	none	W.
May	61.7	86	41	.13	7	3	21	3	none	none	W.
June	60.0	86	42	----	10	16	4	none	none	none	W.
July	62.0	85	46	----	14	14	3	none	none	none	W.
August	65.4	92	48	----	10	10	11	none	none	none	W.
September	63.3	80	48	.55	2	14	14	2	none	none	W.
October	61.8	92	34	----	19	12	----	none	2	none	W.
November	58.3	86	36	.70	26	2	2	1	none	none	W.
December	53.6	76	33	3.40	15	5	13	8	4	none	W. & E.
For the year	58.0	†92	‡28	13.11	130	116	119	43	27	7	W.

* Cloudy days include all that are both cloudy and rainy. † In August and October. ‡ In January.

STEELE STATION, SAN LUIS OBISPO COUNTY, CAL.

Weather summary for the year 1890 at Steele Station (Edna Post Office), San Luis Obispo County, California. By A. T. Mason, Observer:

Month.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation
January	53.1	35.2	44.1	58	32	6.45
February	58.6	41.5	51.0	74	33	4.66
March	63.1	45.0	54.0	75	38	2.96
April	66.1	47.0	56.5	87	39	.30
May	70.0	51.1	60.5	87	42	.40
June	72.4	48.9	60.7	87	44	--------
July	78.2	50.2	64.2	88	47	--------
August	77.0	54.5	65.7	92	48	--------
September	74.7	52.9	63.8	85	49	.91
October	78.0	50.2	64.1	91	41	--------
November	70.0	46.3	58.2	82	39	1.37
December	63.6	46.1	54.8	71	41	4.82
For the year	68.9	47.4	58.1	*92	†32	20.96

*In August. †In January.

SANTA BARBARA, CAL.

By Prof. Hugh D. Vail.

The following synopsis of the weather for the year 1890 is compiled from daily observations of temperature as shown by self-registering thermometers in my observatory, and the movement of wind as measured by a Robinson anemometer:

Month.	Mean Monthly Temperature	Mean Maximum Temperature	Mean Minimum Temperature	Rainfall, Inches	Hourly Movement of Wind, Miles	Relative Humidity	Clear Days	Fair Days	Cloudy Days
January	48.4	55.0	43.5	5.32	3.6	69	20	5	6
February	52.6	68.2	45.0	2.96	3.7	66	19	2	7
March	55.6	61.5	50.3	1.10	4.2	65	18	4	9
April	56.6	69.8	51.8	.31	3.2	76	13	4	13
May	60.0	75.0	53.7	.18	3.4	75	11	5	15
June	62.4	74.5	56.2	.06	3.4	72	21	2	7
July	67.3	71.3	63.5	--------	3.6	73	29	1	1
August	67.9	83.3	62.5	--------	3.4	75	19	7	5
September	66.5	71.3	62.7	1.50	3.0	79	15	7	8
October	64.0	75.5	54.3	--------	2.7	70	26	5	------
November	63.3	72.5	52.5	.48	2.6	53	28	1	1
December	58.4	65.0	52.5	3.53	2.9	64	19	4	8

The mean temperature of the year was 60.2°, being .4° less than in 1889.

On 41 days during the year the temperature rose above 80° in the warmest part of the day, and on 6 it fell below 35° at night; while there were but 2 nights when it did not fall below 65°.

The highest temperature was 98°, and the lowest 33.5°.

The number of clear days in the year was 238, of fair days 47, and of cloudy, 80.

There were 21 days when the rainfall was over .10 of an inch; but only 8 that could be called rainy.

The mean relative humidity was 70°, and the average velocity of the wind 3.3 miles an hour; while the greatest movement in any one day was 249 miles, or less than 10.5 miles an hour.

Total precipitation for the year, 15.44 inches.

LA GRANGE, CAL.

Weather summary for the year 1890 at La Grange, Cal. By JOSEPH DOMINICI, Observer:

MONTH.	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Rainy Days	Light Frosts
January	42.3	58	27	5.17	14	--------
February	45.9	70	20	3.77	7	4
March	49.0	73	34	2.13	12	2
April	59.8	91	39	1.45	4	2
May	68.6	104	46	1.42	5	--------
June	71.6	104	47	trace	0	--------
July	82.8	105	56	trace	1	--------
August	80.6	111	55	trace	2	--------
September	75.8	107	54	.95	8	--------
October	64.5	92	42	trace	1	--------
November	55.7	85	38	.18	5	3
December	50.0	68	32	2.93	5	3
For the year	62.2	*111	†20	18.00	64	14

* In August. † In February.

LOS ANGELES, CAL.

Highest, lowest, and mean temperature for each month, from 1880 to date, at Los Angeles:

Year.	January.			February.			March.			April.			May.			June.		
	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean	Highest	Lowest	Mean
1880	76.0	30.0	51.3	70.5	33.5	50.1	73.5	36.0	51.1	83.0	40.0	55.9	97.0	42.0	61.1	83.0	50.0	63.4
1881	71.0	37.0	51.7	86.0	42.5	57.9	89.0	37.0	55.8	64.0	48.0	61.4	89.3	41.0	62.7	88.0	48.0	65.6
1882	74.2	32.0	49.4	76.7	32.0	50.3	87.8	35.3	55.3	80.0	40.2	56.4	86.1	42.1	61.7	87.1	49.6	64.4
1883	82.0	30.0	53.5	82.0	28.0	52.3	84.0	42.6	56.7	89.0	39.0	57.3	100.0	39.5	62.1	100.0	52.0	68.8
1884	78.0	33.7	53.9	81.0	38.5	55.1	72.5	37.0	54.8	80.0	41.5	57.2	79.0	47.0	61.6	98.0	49.5	65.6
1885	71.6	38.0	53.9	81.0	36.3	56.6	85.1	42.3	60.6	88.6	44.8	61.9	80.0	48.6	63.5	90.1	47.0	65.0
1886	75.3	32.0	54.7	81.0	41.1	59.5	76.0	37.2	54.3	80.0	42.3	57.2	89.0	44.2	62.4	91.6	48.2	66.1
1887	79.6	33.1	55.4	81.5	35.4	51.6	85.0	41.1	59.1	87.0	40.3	59.1	92.0	44.5	63.1	100.1	46.7	66.1
1888	71.0	30.9	50.0	73.5	39.2	54.4	79.0	35.9	55.1	99.0	44.0	61.9	83.0	45.0	60.8	94.0	50.5	67.5
1889	71.0	32.0	52.4	84.0	33.0	56.4	81.0	44.0	59.2	93.0	46.0	62.2	94.0	46.0	62.6	81.0	51.0	66.4
1890	67.0	34.0	49.0	81.0	35.0	54.0	81.0	40.0	58.0	94.0	42.0	59.0	96.0	43.0	63.0	105.0	48.0	68.0

Year.	July.			August.			September.			October.			November.			December.		
1880	85.0	52.0	64.2	87.0	52.0	66.4	91.0	44.0	64.5	89.0	44.0	62.0	85.0	35.0	55.5	80.0	38.0	55.6
1881	96.1	52.1	68.8	99.8	52.1	69.4	102.0	50.0	67.9	82.3	43.0	60.9	80.8	34.2	57.5	79.3	35.3	54.7
1882	98.1	52.3	68.0	98.9	57.0	71.0	100.0	46.0	67.6	88.0	44.0	63.0	81.0	36.0	57.3	82.0	35.0	56.4
1883	90.0	52.5	69.8	98.0	50.0	69.8	102.5	53.0	71.9	83.0	43.5	61.0	84.0	42.0	59.2	80.0	37.0	56.3
1884	99.0	51.5	70.2	101.5	52.5	71.3	92.5	45.5	65.5	89.1	42.9	62.3	88.0	38.7	59.6	75.6	35.5	52.3
1885	98.5	52.4	70.0	105.6	51.2	72.7	108.5	51.2	69.5	102.3	41.6	64.8	78.5	40.3	59.5	82.0	40.3	57.9
1886	98.1	50.4	69.7	98.1	53.7	71.8	91.3	48.3	65.6	82.2	41.1	59.3	84.9	34.1	56.6	84.8	37.3	55.7
1887	98.1	51.1	69.5	93.6	52.1	68.5	91.0	49.2	68.2	93.2	47.2	65.0	86.0	38.8	60.0	73.2	35.2	53.7
1888	95.0	49.0	67.9	97.0	51.3	67.6	98.2	55.0	68.4	98.0	44.0	61.9	83.8	40.0	57.2	78.8	41.0	55.2
1889	99.0	54.0	70.8	95.0	53.0	71.6	103.0	52.0	72.6	89.0	50.0	66.3	82.0	43.0	61.3	68.0	40.0	54.8
1890	97.0	55.0	73.0	98.0	56.0	73.0	94.0	54.0	71.0	99.0	46.0	68.0	96.0	41.0	66.0	82.0	43.0	61.0

The number of days in each month and each year the temperature was above 90° and below 32°, at Los Angeles:

Month.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
January—Above 90°	.....	0	0	0	0	0	0	0	0	0	0	0	0
Below 32°	.....	0	0	1	0	0	1	0	0	0	0	4	0
February—Above 90°	.....	0	0	0	0	0	0	0	0	0	0	0	0
Below 32°	.....	0	0	0	0	0	2	0	0	0	0	0	0
March—Above 90°	.....	0	1	0	0	0	0	0	0	0	0	0	0
Below 32°	.....	0	0	0	0	0	0	0	0	0	0	0	0
April—Above 90°	.....	0	0	0	1	0	0	0	0	0	0	2	1
Below 32°	.....	0	0	0	0	0	0	0	0	0	0	0	0
May—Above 90°	.....	0	2	1	0	0	3	0	0	0	2	0	1
Below 32°	.....	0	0	0	0	0	0	0	0	0	0	0	0
June—Above 90°	.....	0	3	0	0	0	6	2	1	4	2	3	0
Below 32°	.....	0	0	0	0	0	0	0	0	0	0	0	0
July—Above 90°	3	0	0	0	5	3	0	5	7	9	3	6	5
Below 32°	0	0	0	0	0	0	0	0	0	0	0	0	0
August—Above 90°	0	0	2	0	4	5	8	7	11	13	3	8	5
Below 32°	0	0	0	0	0	0	0	0	0	0	0	0	0
September—Above 90°	1	4	4	1	7	2	10	1	5	1	2	9	8
Below 32°	0	0	0	0	0	0	0	0	0	0	0	0	0
October—Above 90°	0	1	6	0	0	0	0	0	2	0	5	2	0
Below 32°	0	0	0	0	0	0	0	0	0	0	0	0	0
November—Above 90°	0	0	0	0	0	0	0	0	0	0	0	0	0
Below 32°	0	0	0	0	0	0	0	0	0	0	0	0	0
December—Above 90°	0	0	0	0	0	0	0	0	0	0	0	0	0
Below 32°	0	1	1	0	0	0	0	0	0	0	0	0	0
Annual—Above 90°	4	5	18	2	17	10	27	15	26	27	17	30	20
Below 32°	0	1	1	1	1	0	3	0	0	0	0	4	1

RAINFALL AT LOS ANGELES, CAL.

The following figures, from February, 1872, to June, 1877, are from the records of Mr. C. Duncommun, of Los Angeles; from July, 1877, to date, from Signal Office records:

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1872	--------	2.25	.43	.97	.10	none	none	.22	none	none	none	4.42	8.39	1872–73	13.96
1873	2.08	7.19	.05	none	none	none	none	1.06	none	none	.74	5.74	16.86	1873–74	24.78
1874	5.51	9.77	1.09	.45	.42	none	none	none	.06	1.81	1.89	.20	21.20	1874–75	21.67
1875	17.22	.15	.22	.07	.05	none	none	none	none	none	7.57	.82	26.10	1875–76	26.74
1876	6.54	7.92	3.41	.45	.03	none	none	none	none	.40	none	none	18.75	1876–77	5.28
1877	3.48	.01	.83	.26	.30	none	none	none	none	.86	.45	3.93	10.12	1877–78	21.26
1878	3.33	7.68	2.57	1.71	.66	.07	none	none	none	.14	none	4.70	20.86	1878–79	11.35
1879	3.59	.97	.49	1.19	.24	.03	none	none	none	.93	3.44	6.53	17.41	1879–80	20.34
1880	1.33	1.56	1.45	5.06	.04	none	sprin.	sprin.	none	.14	.67	8.40	18.65	1880–81	13.13
1881	1.43	.36	1.66	.46	.01	none	none	sprin.	sprin.	.82	.27	.52	5.53	1881–82	10.40
1882	1.01	2.66	2.66	1.83	.63	sprin.	none	none	sprin.	.05	1.82	.08	10.74	1882–83	12.11
1883	1.62	3.47	2.87	.15	2.02	.03	sprin.	none	none	1.42	none	2.56	14.14	1883–84	38.22
1884	3.15	13.37	12.36	3.58	.39	1.39	.02	.02	sprin.	.39	1.07	4.65	40.39	1884–85	9.29
1885	1.05	.01	.01	2.01	.06	sprin.	sprin.	sprin.	.05	.30	5.55	1.65	10.69	1885–86	22.72
1886	7.78	1.41	2.52	3.32	.01	.11	.27	.21	.11	.02	1.18	.26	17.22	1886–87	14.42
1887	.20	9.25	.29	2.36	.20	.07	.07	sprin.	.18	.17	.80	2.63	16.07	1887–88	14.09
1888	6.04	.80	3.17	.12	.05	.01	.04	.10	.03	.40	4.02	6.26	21.04	1888–89	19.42
1889	.25	.92	6.48	.27	.65	.01	trace	.28	.34	6.96	1.35	15.80	33.31	1889–90	34.84
1890	7.83	1.36	.66	.22	.03	.02	none	.03	.06	.03	.13	2.32	12.49	1890–91	*2.57

* To January 1, 1891.

The number of clear, fair, and cloudy days in each month and each year, from 1880 to 1890, inclusive, at Los Angeles:

Month.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
January—Clear	20	17	18	21	17	*17	13	21	14	19	10
Fair	10	9	6	6	8	*10	6	10	8	6	13
Cloudy	1	5	7	4	6	3	12	0	9	6	8
February—Clear	16	14	16	13	11	16	20	13	14	18	15
Fair	8	12	9	9	8	11	4	9	8	8	9
Cloudy	5	2	3	6	10	1	4	6	7	2	4
March—Clear	16	15	15	6	9	14	14	18	10	9	13
Fair	10	13	5	14	11	12	11	12	12	18	13
Cloudy	5	3	11	11	11	5	6	1	9	4	5
April—Clear	8	6	16	10	11	11	13	11	14	12	6
Fair	10	13	9	18	13	12	10	10	8	13	20
Cloudy	12	11	5	2	7	7	7	9	8	5	4
May—Clear	15	9	12	12	7	4	14	14	5	9	5
Fair	11	15	11	15	16	21	14	*11	18	19	18
Cloudy	5	7	8	4	8	6	3	5	8	3	8
June—Clear	7	12	11	15	8	15	*10	17	17	1	9
Fair	22	16	14	12	9	14	*16	10	12	28	21
Cloudy	1	2	5	3	13	1	3	3	1	1	0
July—Clear	5	11	9	11	24	14	15	13	17	15	20
Fair	23	19	22	19	7	16	14	13	13	16	11
Cloudy	3	1	0	1	0	1	2	5	1	0	0
August—Clear	12	12	*16	20	23	16	21	11	23	14	10
Fair	16	18	*6	10	8	14	8	20	8	16	20
Cloudy	3	1	1	1	0	1	2	0	0	1	1
September—Clear	6	16	26	22	20	18	15	15	21	11	12
Fair	23	11	2	8	8	12	15	12	7	18	12
Cloudy	1	2	2	0	2	0	0	3	2	1	6
October—Clear	9	19	20	13	25	21	15	24	16	6	25
Fair	16	9	9	14	4	10	14	6	10	20	2
Cloudy	6	3	2	4	2	0	2	1	5	5	4
November—Clear	17	25	16	18	21	14	22	18	15	18	25
Fair	12	5	8	11	7	8	7	9	8	8	4
Cloudy	1	0	6	1	2	8	1	3	7	4	1
December—Clear	10	15	22	22	*13	21	18	21	18	8	13
Fair	10	14	8	7	*11	5	12	7	6	11	12
Cloudy	11	2	1	2	6	5	1	3	7	12	6
Annual—Clear	141	172	197	183	189	181	190	196	184	140	163
Fair	171	154	109	143	110	145	131	129	118	181	155
Cloudy	54	39	51	39	66	38	43	39	64	44	47

* Records incomplete.

RIVERSIDE, CAL.

Weather summary for the year 1890, at Riverside, Cal. By W. E. Keith, Observer:

Month.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Clear Days	Fair Days	Cloudy Days	Rainy Days	Light Frosts	Prevailing Wind—Direction
January	55.5	34.5	43.1	66.5	26.5	4.28	16	8	7	10	16	W.
February	65.3	38.4	50.2	82.0	28.0	1.76	17	6	5	9	7	W.
March	70.6	41.3	53.3	83.0	32.0	.55	11	14	6	4	2	W.
April	75.4	45.8	58.0	93.0	35.5	.06	9	16	5	1	none	W.
May	79.4	50.7	62.6	96.5	38.5	.17	9	15	7	2	none	W.
June	87.8	50.9	67.1	108.0	43.5	none	14	16	none	none	none	W.
July	96.8	58.3	76.1	109.0	50.5	none	27	3	1	none	none	W.
August	90.9	60.7	74.1	105.0	52.5	.55	20	8	3	2	none	W.
September	89.7	56.5	69.1	104.0	49.0	.71	20	4	6	5	none	W.
October	86.0	48.0	63.1	97.0	38.0	.07	25	3	3	1	none	W.
November	78.5	43.1	57.8	95.0	35.5	.33	26	3	1	1	none	N.
December	66.7	43.3	54.0	78.0	33.5	3.07	14	9	8	5	1	E.
For the year	78.5	47.6	60.7	*109.0	†26.5	11.55	208	105	52	40	26	W.

There were no killing frosts during the year.

* In July. † In January.

RAINFALL AT RIVERSIDE, CAL.

The following rainfall record by months, years, and seasons was furnished by Mr. ALBERT S. WHITE, of Riverside, San Bernardino County, through W. E. KEITH, and covers the period from November, 1880, to date:

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1880	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	.20	2.16	-----	-----	-----
1881	.48	.25	1.30	.74	.03	none	none	none	.10	.40	.25	.40	3.95	1881–82	6.31
1882	1.70	1.40	1.08	.72	.08	.18	none	none	none	.13	.29	.20	5.78	1882–83	2.94
1883	.09	.83	.89	.26	.25	none	none	none	none	.97	none	2.25	5.54	1883–84	22.74
1884	.84	7.94	6.56	1.67	1.99	.52	none	3.00	none	.12	.12	2.56	25.32	1884–85	8.97
1885	.77	none	.01	2.15	.24	none	none	none	none	.02	1.34	.62	5.15	1885–86	9.42
1886	2.68	1.38	1.95	1.43	none	none	none	none	none	none	.54	.04	8.02	1886–87	5.92
1887	.13	3.30	.02	1.70	.17	.02	none	none	none	.75	.87	.85	7.81	1887–88	11.75
1888	4.17	1.05	3.84	.18	.04	none	none	none	none	none	2.83	3.37	15.48	1888–89	15.55
1889	.87	1.30	5.10	1.83	.25	none	none	none	.09	1.35	1.82	7.80	20.41	1889–90	18.19
1890	4.28	1.76	.55	.06	.17	none	none	.55	.71	.07	.33	3.07	11.53	1890–91	*17.90

* Up to January 1, 1891.

RAINFALL AT SAN BERNARDINO, CAL.

The rainfall at San Bernardino was furnished by Mr. SIDNEY P. WAITE, of the San Bernardino Water Company, and extends from July, 1870, to date:

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for Year.	Season of.	Total for Season.
1870	--------	--------	--------	--------	--------	--------	none	none	.02	.09	3.11	.89	--------	1870–71	13.94
1871	6.91	2.21	.19	.34	.11	.07	none	.04	.13	.60	.88	3.91	15.39	1871–72	8.98
1872	none	2.20	.37	.79	.06	none	none	.18	.04	none	1.17	4.40	9.21	1872–73	15.10
1873	6.50	1.25	.51	.84	.21	none	none	1.06	.02	.01	.74	5.73	16.87	1873–74	23.81
1874	5.51	8.76	1.08	.48	.42	none	none	none	.06	1.82	1.88	2.20	23.21	1874–75	13.65
1875	7.20	.15	.22	.07	.05	none	none	none	none	none	7.50	.02	15.21	1875–76	19.90
1876	6.55	1.92	3.41	.44	.03	.03	none	none	none	.20	.40	none	12.98	1876–77	9.52
1877	3.50	4.03	.83	.26	.30	none	none	none	none	.86	.50	3.95	14.23	1877–78	20.33
1878	3.33	6.68	2.57	1.71	.66	.07	.07	none	.02	.14	.05	4.70	20.00	1878–79	11.54
1879	3.59	1.00	.50	1.20	.24	.03	.11	.02	.01	.94	3.40	6.50	17.54	1879–80	20.36
1880	1.56	1.33	1.45	5.00	.04	none	none	none	none	.14	.67	8.80	18.99	1880–81	13.50
1881	1.40	.36	1.66	.46	.01	none	none	none	none	.80	.27	.50	5.46	1881–82	11.54
1882	†.11	2.65	3.30	2.91	none	none	none	none	none	.10	.15	.45	9.67	1882–83	9.17
1883	1.60	1.10	2.82	2.95	none	none	.19	none	.53	.85	.09	2.63	12.76	1883–84	37.51
1884	1.63	12.20	9.95	5.68	3.17	.59	none	none	none	none	.11	3.75	37.08	1884–85	10.81
1885	2.79	.11	.28	1.89	1.69	.19	none	none	none	.39	4.36	1.20	12.90	1885–86	21.93
1886	6.44	2.52	4.18	2.36	.32	.16	none	none	none	none	.11	.61	16.70	1886–87	14.50
1887	.39	6.44	4.41	1.90	.42	.22	.11	.04	.09	1.17	2.29	1.91	19.39	1887–88	17.76
1888	4.01	3.60	3.41	.58	.52	.03	none	none	none	.05	4.12	4.64	20.96	1888–89	20.97
1889	.93	1.50	6.55	2.05	1.13	none	.17	.63	.11	2.30	2.23	10.85	28.45	1889–90	25.94
1890	5.15	2.40	.89	none	.31	none	.13	2.16	.88	.58	1.27	3.02	16.79	1890–91	*8.04

* Up to January 1, 1891. † Twelve inches of snow, January 12, 1882.

SAN DIEGO, CAL.

The following meteorological data, at San Diego, was furnished by M. E. HEARNE, Observer Signal Corps, in charge:

1890:	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	For the Year.
Mean temperature	51.00	54.00	56.00	59.00	60.00	64	68	70	69.00	65.00	64.00	61.00	62.00
Mean maximum temperature	58.00	62.00	65.00	65.00	66.00	71	74	75	75.00	71.00	76.00	69.00	69.00
Mean minimum temperature	41.00	46.00	48.00	52.00	55.00	57	63	64	63.00	55.00	52.00	52.00	54.00
Mean vary of temperature	15.00	16.00	17.00	12.00	11.00	13	12	11	12.00	19.00	24.00	17.00	15.00
Greatest vary of temperature	31.00	39.00	33.00	40.00	29.00	42	24	31	23.00	41.00	45.00	32.00	34.00
Days temperature above 90°	--------	--------	--------	--------	--------	2	--------	--------	--------	1.00	1.00	--------	2.00
Days temperature below 32°	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
Total rainfall	2.99	1.70	.41	.05	.08	--------	--------	trace	.65	.01	.72	1.61	8.02
Greatest rainfall in any twenty-four hours	1.32	1.04	.38	.03	.04	--------	--------	trace	.37	.01	.72	1.23	--------
Wind velocity	3,698	3,515	3,642	3,696	3,433	3,890	3,499	3,446	3,118	3,005	3,078	3,335	41,355
Maximum wind velocity	28	30	24	20	21	21	20	23	24	21	21	26	*30
Direction of maximum wind velocity	S.	S.	N.W.	S.E.	N.W.	S.W.	S.W.	N.W.	N.W.	S.W.	N.E.	S.E.	S.
Clear days	1	13	11	9	12	15	18	14	18	23	23	14	185
Fair days	11	3	9	8	7	15	9	7	1	3	5	5	83
Cloudy days	5	12	11	13	12	--------	4	10	11	5	2	12	97
Rainy days	9	9	4	2	3	--------	--------	--------	5	1	2	6	41

*Highest.

SWEETWATER DAM, SAN DIEGO COUNTY, CAL.

Weather summary for the year 1890 at Sweetwater Dam (National City), near San Diego, San Diego County, Cal. By Mr. JOHN BOAL, Observer:

MONTH.	Mean Maximum Temperature	Mean Minimum Temperature	Mean Monthly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation	Clear Days	Fair Days	Cloudy Days	Light Frosts	Prevailing Wind—Direction
January	58.19	40.10	49.145	69	30	2.22	*17	†12	2	12	N.E.
February	63.17	43.11	53.14	79	35	2.73	14	‡9	5	0	N.E.
March	66.94	45.26	56.10	76	38	.64	16	§12	3	0	W.SW.
April	67.70	50.36	58.71	84	40	.13	7	18	5	0	S.W.
May	67.84	51.87	59.85	79	55½	.41	9	14	8	0	S.W.
June	75.63	55.73	65.68	104	41	--------	20	10	0	0	S.W.
July	81.06	60.39	70.73	92	53	--------	25	6	0	0	S.W.
August	82.35	60.39	71.37	104	52	--------	23	8	0	0	S.W.
September	81.20	61.63	71.41	94	57	.87	19	9	2	0	S.W.
October	80.06	52.71	66.39	98	45	--------	25	6	0	0	S.W.
November	80.40	48.83	64.62	98	43	.93	26	3	2	0	W.
December	71.93	49.71	60.82	83	45	2.43	15	11	5	0	N.W.
For the year	73.04	51.674	62.3	88.3	44.54	10.36	216	118	32	12	--------

* Of the "clear days," four show precipitation at night.
† Of the "fair days," four show precipitation at night.
‡ Of the "fair days," seven show precipitation at night.
§ Of the "fair days," two show precipitation at night.

JULIAN, SAN DIEGO COUNTY, CAL.

Weather summary for the year 1890 at Julian, San Diego County; elevation, four thousand feet. By W. A. Sickler, Observer:

Month.	Mean Monthly Temperature	Total Precipitation
January	41.0	6.12
February	47.1	10.39
March	51.3	3.63
April	57.4	1.11
May	60.1	2.54
June	68.0	.00
July	74.6	.00
August	71.4	1.25
September	71.1	1.25
October	58.4	.00
November	56.7	2.00
December	50.0	6.36
For the year	58.9	34.75

TEMPERATURE AND RAINFALL AT VARIOUS PLACES.

Mean temperature, highest and lowest temperature, and total precipitation for the year 1890, at the following Voluntary Signal Service Stations throughout California, from the report of the annual summary issued from the United States Signal Office, Washington City, D. C.:

Stations.	Mean Yearly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation—Inches
Alcatraz Island	53.4	85	26	23.33
Almaden	58.8	94	28	25.59
Anaheim	66.8	107	32	9.52
Angel Island	55.4	91	29	19.55
Antioch	62.6	107	25	13.92
Athlone	64.2	110	27	11.20
Auburn	59.6	105	24	34.04
Bakersfield	66.7	109	30	3.50
Barstow	63.9	114	22	1.89
Beaumont	62.7	105	24	16.29
Benicia Barracks	57.7	100	27	22.78
Berendo	63.9	113	25	10.73
Berkeley	54.5	86	31	28.79
Boulder Creek	56.2	110	23	65.68
Brighton	62.4	106	30	16.74
Castroville	57.1	87	30	17.19
Centerville	61.1	100	34	19.54
Chico	61.5	111	28	21.78
Cisco	43.9	87	10	62.36
Colgrove				12.05
Colfax	58.5	102	20	55.49
Colton	66.7	110	26	7.96
Crescent City				81.50
Delta	58.7	106	20	70.54
Dunnigan	64.0	116	31	21.63
Elmira	62.5	110	31	25.02

Temperature and Rainfall at Various Places—Continued.

Stations.	Mean Yearly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation—Inches
El Verano	57.6	100	27	35.37
Emigrant Gap	48.1	92	15	52.11
Evergreen				18.41
Felton	61.1	100	26	50.22
Folsom	61.9	108	26	29.25
Fort Gaston	55.1	105	24	57.98
Fort Mason	54.4	81	35	23.42
Fresno	66.9	112	29	7.63
Georgetown	56.3	98	18	62.83
Gilroy	58.1	99	26	23.34
Girard	57.4	99	17	10.75
Goshen	64.4	110	26	7.63
Haywards	55.4	87	30	21.38
Hollister	60.0	101	28	13.14
Hydesville	51.3	86	24	47.98
Ione	58.4	105	21	22.32
Iowa Hill	58.3	101	22	62.29
Julian	59.1	96	24	34.65
Keene	58.8	102	21	14.38
Kingsburg	63.0	106	25	8.54
Kings City	57.8	100	22	11.24
Knights Landing	61.9	102	31	18.07
Lathrop	62.4	105	30	11.54
Laurel	58.9	101	29	53.78
Lodi	58.8	103	26	20.06
Lemoore	64.2	110	25	6.31
Livermore	58.8	102	22	17.05
Los Angeles	64.7	106	32	13.87
Los Gatos	60.6	101	26	34.30
Mammoth Tank	75.8	118	29	1.60
Martinez	57.8	92	28	23.75
Modesto	61.9	107	21	10.51
Montague	56.6	104	—6	18.30
Monterey	55.2	86	28	15.96
Napa	57.2	99	25	30.66
National City	62.9	104	30	10.43
Newark	59.8	92	28	16.44
Niles	60.8	96	26	18.59
North Hill Vineyard (Milton)	62.0	104	28	17.24
Norwalk	65.3	110	30	7.34
Oakland	56.2	90	30	26.15
Pajaro	56.0	100	30	21.60
Paso Robles	57.9	106	23	18.43
Petaluma	58.2	100	28	25.65
Placerville	56.6	104	18	52.01
Porterville	65.7	110	30	8.87
Puente	64.1	106	32	10.67
Red Bluff	63.6	108	28	24.45
Redding	62 5	115	20	35.82
Riverside	60.8	109	26	11.55
Rocklin	62.7	107	30	22.69
Rumsey	64.5	110	28	28.57
Sacramento	60.0	94	21	23.78
Salinas	54.8	95	30	16.03
San Diego Barracks	62.6	90	34	7.83
San Fernando	64.5	108	26	10.95
San Gabriel	64.6	106	28	11.80
Sanger Junction	67.1	111	28	9.35
San José	57.8	93	30	16.04
San Mateo	54.9	86	30	21.45
San Pedro	64.6	100	35	6.51
Santa Ana	65.6	106	32	12.88
Santa Barbara	60.2	98	34	15.49
Santa Cruz	59.7	93	32	25.30
Santa Margarita	54.4	104	20	26.59

Temperature and Rainfall at Various Places—Continued.

Stations.	Mean Yearly Temperature	Highest Temperature	Lowest Temperature	Total Precipitation—Inches
Santa Maria	58.0	92	29	17.18
Santa Rosa	56.2	100	27	31.08
Selma	63.8	107	27	9.10
Sims	54.8	105	10	75.04
Soledad	56.7	92	26	9.59
Spadra	64.0	108	30	9.54
Steeles	58.3	92	32	19.59
Suisun City	59.8	103	30	22.60
Susanville	51.0	100	—10	24.86
Tehachapi	54.4	93	14	6.73
Tehama	64.4	112	32	14.60
Templeton	58.6	108	25	19.34
Traver	63.8	104	25	10.21
Truckee	43.6	92	—22	39.40
Tulare	66.2	111	31	8.22
Turlock	63.4	106	29	9.68
Upper Mattole	56.9	106	26	90.06
Vacaville	60.7	107	30	31.39
Valley Springs	60.3	102	28	24.30
Vina	63.4	108	28	18.72
Volta	63.3	106	28	7.56
Walla Walla Creek (Fort Jones)	48.8	94	3	35.53
Walnut Creek	58.9	113	27	20.38
Westley	65.8	105	28	9.27
Wheatland	59.5	106	27	19.51
Whittier	66.2	106	35	9.15
Williams	60.6	109	26	14.36
Willows	59.4	108	28	15.81
Winters	65.8	110	31	28.22
Woodland	60.1	100	28	19.18

CHARTS OF PACIFIC COAST CYCLONE TRACKS AND PRECIPITATION.

By J. P. Finley, Lieutenant Signal Corps, officer in charge San Francisco Signal Office.

Generally speaking, the rainfall of a place is determined by its location relative to the course of cyclonic movements for its particular region. This statement is especially true of the Pacific Coast States, and it is proposed to illustrate the fact by a cartographical representation of storm paths and precipitation for typical months of the year. I have selected July, October, and December for the years 1889 and 1890 (see charts Nos. III, IV, V, and VI), because they present other features pertaining largely to excessive and deficient precipitation which it is very important to invite attention to. The charts as prepared show precipitation decimally, in inches, tenths, and hundredths, and cyclone tracks in heavy black lines. The storm tracks are intended to indicate the course of movement of the centers of cyclonic disturbances, but owing to the lack of daily observations over the ocean and northward along the coast, from Washington, these paths can only be approximately traced. From October to April, inclusive, the cyclonic centers generally deflect southward in their easterly course into Washington,

occasionally into Oregon, but rarely into California, and then only in the extreme northern portion of that State. There appears to be no record of a cyclone center coming as far south as San Francisco. From May to September, inclusive, cyclonic disturbances all pass eastward north of Washington. During these months the progressive easterly movement is at such a high latitude that it is impracticable to indicate on the charts used the location of the storm centers. The July chart shows those storms which came farthest south, by broken lines, to indicate that the paths thus designated are very uncertain as to their location. It is positively known that they did not come south into Washington, but just where they entered the coast and passed over British Columbia it is impossible to exhibit on existing charts, with the data available.

This typical summer chart clearly shows the marked difference in the latitude of easterly cyclonic movements, as compared with the conditions that prevail during the winter. The effect of this change in direction upon the amount and distribution of precipitation is graphically shown by the charts accompanying this paper. To clearly understand these charts and appreciate what they demonstrate, it is important that the reader should be informed as to the place of origin of the cyclones of the Pacific Coast, and as to the development of these atmospheric disturbances in general. As the weather of a place depends upon atmospheric conditions developed to the westward of it, brought therefrom under the influence of cyclonic circulation and the rotation of the earth, we must look in that direction for the source of storm supply. The food of a storm is heat and moisture, and without an adequate and unceasing supply of these elements cyclonic formation and all of its attendant features would fail of development or continuance.

In the North Pacific an abundant source of food supply for storms is found in the Japan current. It is over this vast stream of warm water, coursing through the ocean from west to east, that the air is set in motion by upward currents which are constantly forming from the accumulation of heat and moisture, and give the initiatory movement to cyclonic formation. These vast eddies in the air drift along under the influence of the general easterly trend of the atmosphere, growing in energy while they can keep near the source of food supply. Upon reaching the coast the Japan current is left behind, and the cyclones make their way over the continent with diminishing intensity until entering the Mississippi Valley, when another source of food supply (the Gulf of Mexico) is made available, and later on the Gulf Stream. The influence of the great Mississippi Valley is enormous upon all storm movements from the north and west of that region. Upon the approach of an area of low barometric pressure from the Rocky Mountains the winds shift to southerly in the great valley, and vast volumes of warm, moist air are carried into the circulation of the cyclone. The configuration of the valley is such that the air is drawn to the northward by the peculiar circulation of the cyclonic disturbance, and the currents are necessarily heavily freighted with heat and moisture. Blot out the Mississippi Valley, place in its stead great mountain chains bordering the gulf, and raise the land to the elevation of the great western plateau, and the now garden spot of the world would become like the arid plains of Wyoming, Utah, and Nevada. Not less powerful is the influence of the Gulf Stream on the meteorological conditions and climate of the Atlantic coast of this country.

There is no question as to development of cyclonic action along the Japan current. The logs of all vessels which have ever entered or crossed that current furnish abundant evidence as to storms, violent squalls, and high seas. Every one at all familiar with meteorology has some knowledge of the character of the furious typhoons in the China and Japan seas. These storms become, later on in their easterly course, the cyclones that sweep the coast of Alaska and British Columbia, and thence pass to the interior of the United States, some of which finally reach the north Atlantic, and even pass over Europe, preserving their identity in a remarkable manner. Cyclonic formations have thus been traced entirely around the globe in the northern hemisphere. From this brief reference to cyclonic developments information can be drawn which will make the storm track lines on the accompanying charts more intelligible. To understand the relation of the distribution of precipitation to cyclonic formation and movement, it will be important to briefly consider the character of a cyclone in this respect. We may divide the area of a disturbance, which usually varies from five hundred to fifteen hundred miles in diameter, into four quadrants, each of which will show distinct features, described as follows: These quadrants have atmospheric characteristics which they maintain as long as the identity of the cyclone continues. The northeast quadrant is distinguished by great humidity, high winds, and heavy cloud formation, especially in the southern portion, together with precipitation. The southeast quadrant contains the maximum of heat and moisture; it is the region of all classes of local storms, especially the tornado. The southwest quadrant is marked by clearing weather, with dashes of rain in the eastern portion, falling temperature, and diminishing humidity. The northwest quadrant has the minimum of heat and moisture, general absence of clouds, and brisk cold winds. From the nature, then, of cyclonic formation, precipitation is confined to certain parts of the circulation which forms the area of lowest barometric pressure. The rain area extends to the south and east, from three hundred to five hundred miles in advance of the cyclonic center. Generally speaking, the heaviest precipitation will occur near the center, modified more or less by local conditions.

As a cyclone approaches the northwest coast of this continent the rain area gradually extends southward into the Pacific Coast States. If the center comes southward into Oregon the rainfall will be heavier in California than in Washington. Under such circumstances the former region is brought completely within the influence of the rain quadrants of the "low," or cyclonic, area. This condition of cyclonic movement occurs only in what is called the "wet season," in California. In the "dry season" the cyclones move eastward at such high latitudes that the rain quadrants of the "low" do not reach further southward than Washington and northern Oregon, and in many cases only the extreme southern edge of the rain area touches northern Washington. In the northern hemisphere storms move eastward at a lower latitude in the winter than in summer, probably due to the apparent movement of the sun north and south of the equator. The earth, in passing through its orbit about the sun, receives the rays from that luminary at constantly varying angles. In summer, in the northern hemisphere, the rays are less oblique, and therefore the heating effect is more pronounced. In winter the reverse condition prevails. The direction of cyclonic movement is largely controlled by the presence of heat and moisture. Cyclones find their food supply of these elements at a higher latitude

in summer than in winter. Therefore, their deflection southward is greatest in winter. The natural course of the cyclones of the North Pacific is directly eastward from the northern portion of the Japan current. This line of movement, if continued, would carry the paths of the storm centers eastward over Hudson Bay, and thence to the Atlantic, over Labrador. After leaving the coast of British Columbia, in passing eastward to about the one hundredth meridian, the cyclonic areas begin to feel the effect of the heat and moisture of the Gulf of Mexico, and further eastward in their course the Gulf Stream. The great Mississippi Valley affords a natural gateway for the sweeping northward of immense masses of warm, moist air. Under this influence the cyclonic centers are drawn southward into the United States, and thence eastward across the Great Lakes, or at a lower latitude, over the Ohio Valley, reaching the Atlantic in the vicinity of 45 degrees north latitude. The course of the cyclones of the North Pacific is thus briefly defined, together with the conditions under which they are maintained, in their passage across the continent. We have also shown the connection between a moving cyclone and the consequent area of precipitation. It can be readily seen, then, that the rainfall of the Pacific Coast States depends upon the latitude, number, and intensity of the cyclones from the Japan current.

The cyclones come further south in winter than in summer, as before explained, hence the "dry season" from May to September, inclusive, which prevails generally over the region south of the forty-second parallel and west of the one hundred and twelfth meridian. North of this parallel there is practically no "dry season," as northern Oregon and Washington have rain throughout the year, but more in winter than in summer, for reasons before given.

Reports from Alaskan stations show the effect of the passage of cyclonic areas throughout the year. The normal rainfall at these stations from May to September, inclusive, varies from 2.50 to 5.80 inches. In some instances the rainfall in May has been over 10 inches, in August nearly 7 inches, and in September over 13 inches; generally, the rainfall in winter is heavier than in summer, the normal being about 5 inches. When the cyclonic movement takes place at an abnormally low latitude, heavy rains occur in the Pacific Coast States and light rains in Alaska and British Columbia. In November, 1885, when the rainfall in Northern California was exceedingly heavy, varying from 6 to 24 inches, the rainfall at Alaskan stations was below the normal, from 1 to nearly 3 inches. In November, 1884, when the rainfall in the Pacific Coast States was decidedly below the normal, especially in California, where in many places no rain fell at all, the precipitation in Alaska was largely above the normal, Sitka reporting a fall of 16.31 inches. In November, 1883, the rainfall was very light and below the normal at all stations in the Pacific Coast States, while in Alaska it was heavy and above the normal. Sitka reported 10.63 inches, Atka 14.72, and Oonalaska 5.02. Alaska and the Aleutian Archipelago bear somewhat the same relation to cyclones entering British America from the North Pacific as do the Canadian maritime provinces to cyclones entering the North Atlantic from the United States. The former region may be called the port of entry and the latter the port of departure for the cyclonic movements of North America. The region south of the forty-second parallel, including California and the Middle Plateau, is not entirely devoid of precipitation during the summer. There is

always more or less rain, according to the amount of snowfall during the winter. The rain of summer, or what is called the "dry season," comes from the evaporation of snow. The light rains, occasionally heavy at this season, are the result of local conditions, and are not produced as the effect of cyclonic circulation in areas of low barometric pressure. The great masses of snow which collect upon the Sierras, the highest of which are in perpetual snow during the passage of the winter cyclones, form the only source of supply for the occasional showers of summer. No snow in winter means no rain in summer, and *vice versa*. Remove the mountains from California and the plateau regions, and that country would suffer severely from protracted droughts. Constant and rapid evaporation goes on from the snow-covered mountains, under the fierce rays of the mid-summer sun. Early in the day heavy cloud masses can be observed forming along the crest line of the ranges, and just after the hottest part of the day these heavy collections of moisture, suspended in the air, gradually dissolve in the production of sudden downpours of rain, sometimes accompanied with heavy peals of thunder and vivid flashes of lightning. It is not an uncommon thing for an observer to watch, from a mountain peak, the entire process of evaporation, cloud formation, and rain development going on just below the level of his station. During the winter of 1889–90 the snowfall was extremely heavy in the Pacific Coast States, as is well known. The melting of this snow during the following spring and summer gave rise to heavy and disastrous floods, and severe local storms. In July and August there were an unusual number of severe local storms in California, Nevada, and Arizona. At Palmetto, Nevada, in August, 8.60 inches were reported as falling in one hour, and 8.80 inches in about two hours, causing great damage to roads. At Tucson, Arizona, over sixty miles of railroad track were washed away during August.

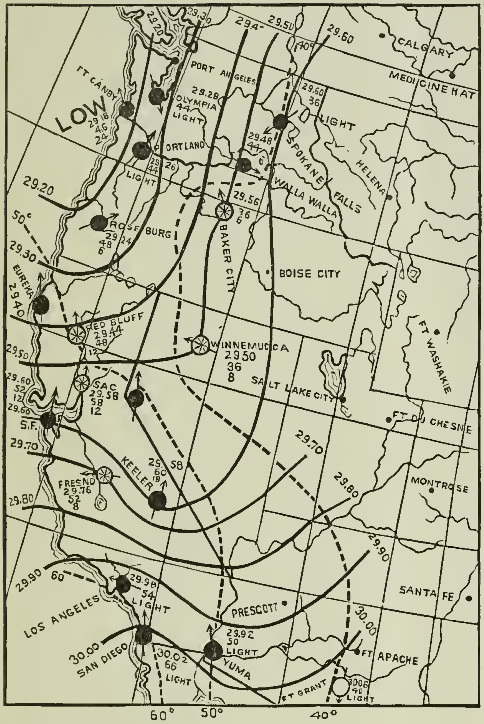
The general uniformity of climatic conditions in the Pacific Coast States, and the peculiar meteorological features of temperature and precipitation, are due, primarily, to the location and direction of movement of the Japan current. The weather and climate of a region are determined, principally, by their relation to the prevailing course of cyclonic movement. Reverse the course of the Japan current, the motion of the earth remaining the same, and California and the Middle Plateau would have the weather and climate of the South Atlantic and East Gulf States, rather than that of Spain and southern France. The most important adjunct in the development of knowledge of Pacific Coast weather, and in increasing the reliability and extent of the daily weather forecasts and storm warnings, will be the establishment of telegraphic communication between the United States, British Columbia, and Alaska. We must receive telegraphic weather reports from as far northwest as possible, along the coast of British Columbia and along the northern border of the Japan current. This great desideratum can be accomplished by connecting certain of the islands of the Aleutian Archipelago by cables and telegraph lines to Alaska, and thence to the United States along the coast of British Columbia. From these outposts in mid-ocean the very inception of cyclonic development can be watched, and reports as to the progress and intensity of these storms flashed to the central office in San Francisco several days in advance of their arrival on the California coast.

[Chart No. 1, Daily Weather Map.]

WAR DEPARTMENT WEATHER MAP.

(Published by authority of the Secretary of War.)

United States Signal Service, Division of the Pacific,
San Francisco, Cal., December 3, 1890.



Stations.	Rainfall Past 24 Hours	Seasonal Rainfall to Date	Normal Rainfall	Minimum Temperature
Port Townsend	------	------	------	------
Spokane Falls	0.01	2.77	2.58	34
Helena	------	------	------	------
Olympia	0.40	5.04	9.61	44
Fort Canby	------	------	10.84	------
Walla Walla	0.20	1.58	2.57	32
Portland	0.52	3.57	8.31	42
Baker City	------	------	2.31	------
Roseburg	0.08	1.93	6.65	44
Eureka	------	------	8.08	------
Winnemucca	0.02	0.19	1.22	34
Red Bluff	1.10	2.28	3.76	46
Salt Lake	------	------	------	------
Carson City	------	------	1.84	------
Sacramento	1.00	1.81	4.52	58
San Francisco	1.62	1.95	5.20	50
Fresno	trace.	1.52	1.28	50
Keeler	0.00	2.90	0.38	44
Los Angeles	0.00	0.26	2.73	54
San Diego	0.00	1.32	2.16	54
Yuma	0.00	3.29	0.38	48
Fort Grant	0.00	1.86	1.50	40

Explanatory Notes.—The first four figures are reduced air pressures in inches; next figures, temperatures; and last figures, if any, wind velocities.

Isobars, or heavy black lines, pass through points of equal pressures; and isotherms, or dotted lines, equal temperatures.

Arrows fly with the wind; dark disks indicate cloudy weather; star disks indicate rainy weather; white disks indicate clear weather.

Official Forecasts for Twenty-four Hours, from 8 a. m., 75th Meridian Time, December 3, 1890.

For Northern California—Rain; high southerly winds; nearly stationary temperature, except cooler in the Sacramento and San Joaquin Valleys and in western Nevada. Rain, turning to snow, in the mountains.

For Southern California—Threatening weather and rain; brisk southerly winds; nearly stationary temperature.

For Oregon—Rain; fresh to brisk south to east winds, increasing to high along the coast; nearly stationary temperature.

For Washington—Fresh to brisk northerly winds, increasing to high on the coast; cooler, except nearly stationary temperature at Walla Walla.

Local Data for Twenty-four Hours ending at 8 a. m., 75th Meridian Time, December 4, 1890.

Rain; nearly stationary temperature; maximum temperature, 58 degrees; minimum temperature, 50 degrees; rainfall, 1.67 inches.

[Chart No. II, Blackboard Weather Map.]

SIGNAL SERVICE WEATHER MAP.

Branch Signal Office, Division of the Pacific,
San Francisco, Cal.

Stations.	Rainfall Past 24 Hours	Seasonal Rainfall to Date	Normal Rainfall	Minimum Temperature
Port Townsend				
Spokane Falls				
Helena				
Olympia				
Fort Canby				
Walla Walla				
Portland				
Baker City				
Roseburg				
Eureka				
Winnemucca				
Red Bluff				
Salt Lake				
Carson City				
Sacramento				
San Francisco				
Fresno				
Keeler				
Los Angeles				
San Diego				
Yuma				
Fort Grant				

Weather Forecast.

For Northern California ....

For Southern California ....

For Western Nevada ....

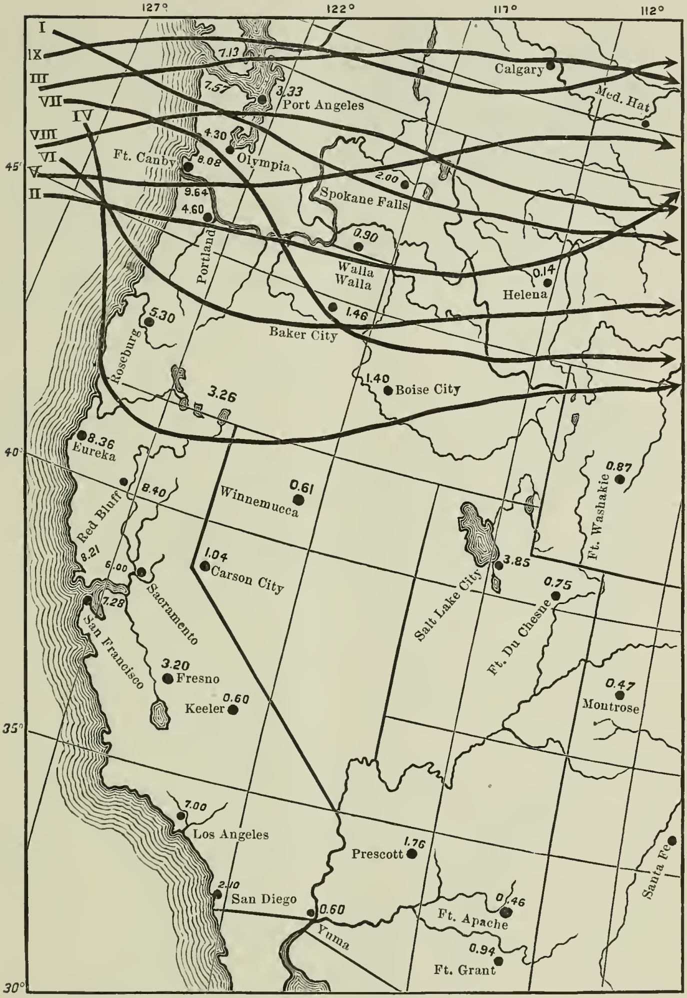
For Oregon ....

For Washington ....

[Chart No. III.]

WAR DEPARTMENT WEATHER MAP.

UNITED STATES SIGNAL SERVICE, DIVISION OF THE PACIFIC,
SAN FRANCISCO, CAL.

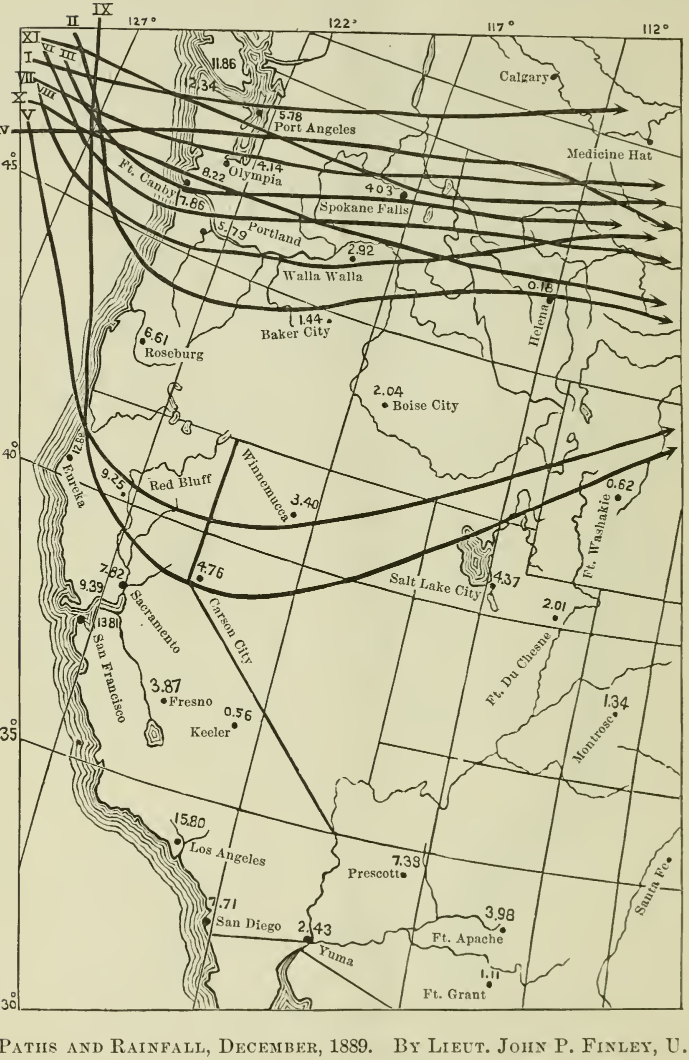


STORM PATHS AND RAINFALL, OCTOBER, 1889. BY LIEUT. JOHN P. FINLEY, U. S. A.

[Chart No. IV.]

WAR DEPARTMENT WEATHER MAP.

UNITED STATES SIGNAL SERVICE, DIVISION OF THE PACIFIC,
SAN FRANCISCO, CAL.



STORM PATHS AND RAINFALL, DECEMBER, 1889. BY LIEUT. JOHN P. FINLEY, U. S. A.

[Chart No. V.]

WAR DEPARTMENT WEATHER MAP.

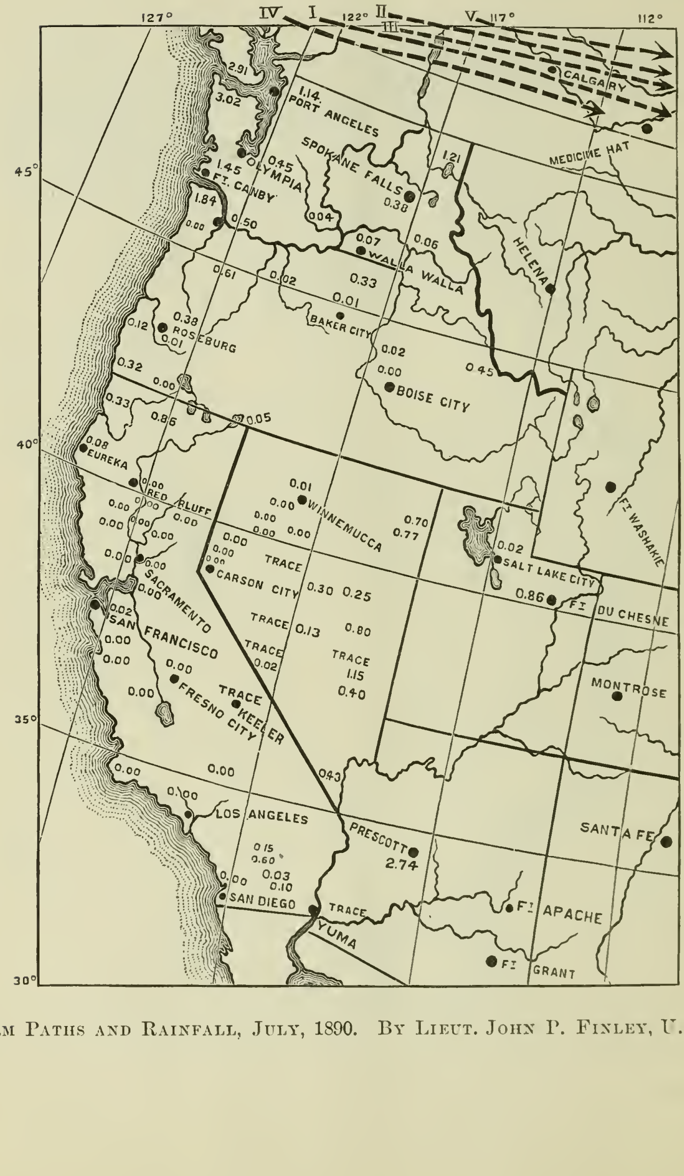
United States Signal Service, Division of the Pacific,
San Francisco, Cal.

Storm Paths and Rainfall, October, 1890. By Lieut. John P. Finley, U. S. A.

[Chart No. VI.]

WAR DEPARTMENT WEATHER MAP.

UNITED STATES SIGNAL SERVICE, DIVISION OF THE PACIFIC,
SAN FRANCISCO, CAL.



STORM PATHS AND RAINFALL, JULY, 1890. BY LIEUT. JOHN P. FINLEY, U. S. A.

THE BLACKBOARD WEATHER MAP.

By J. P. Finley, Lieutenant Signal Corps, officer in charge San Francisco Signal Office.

One of the most important considerations in the preparation of weather information for the public is to secure graphic representation. Weather science is necessarily more or less technical, and the various elements that are of most practical value to the public should be presented in a way to make them readily understood and applied. The value of the data collected and published depends very largely upon the readiness with which the people can comprehend the information. A small paper bulletin has been the usual form for displaying in public places the forecasts, tabulated data of temperature, barometric pressure, wind direction, wind force, and precipitation. Since the establishment of the Signal Service Station at San Francisco, in February, 1871, no radical change had been made in the old form of bulletin display until the appearance of the blackboard weather map. The bulletin serves the purpose, as a matter of necessity, where stations are located in small towns. In large cities, where commercial interests are extensive, and the uses made of weather data are numerous and important, it is imperative to supersede the old bulletin with more comprehensive and conspicuous representation.

Seeing the urgent need for a change in this direction, I gave considerable attention to the development of a scheme which would realize the object sought. As the result of this effort I devised the blackboard weather map, a representation of which is shown by Chart No. II. It consists of three parts: (1) the map, (2) the tabulated data, and (3) the weather forecasts. On the map there appear wind direction, wind velocity, weather, and isometric lines of barometric pressure, showing the position of the low (cyclone) and high (anti-cyclone). Wind direction is indicated by arrows, which fly with the wind, and velocity is shown, in miles per hour, by figures placed near each station. The weather is indicated by a large R for rain and a large S for snow, placed near the station. Fair weather is indicated by an absence of these symbols.

The tabulated data comprises only precipitation and temperature. These are the two weather elements in which Pacific Coast people are most interested, and this is quite true of all sections of the country. In the tabulated statement principal attention is given to precipitation, and for obvious reasons. There is shown the current rainfall for the twenty-four (24) hours, ending at the time the report is issued; rainfall of the season to date, giving the change in this amount from day to day, and the average amount for the current month. By this means there is afforded opportunity to obtain at a glance information as to the various features of rainfall which are of most interest.

The size of the blackboard weather map is such that a large number of people may observe every portion of it at the same time, without hinderance to one another. It measures five (5) by seven (7) feet, and a suitable arrangement of colors secures a clear presentation of every feature. The ground work is black, and the board well slated. The lettering is in light yellow, which stands the weather well and appears

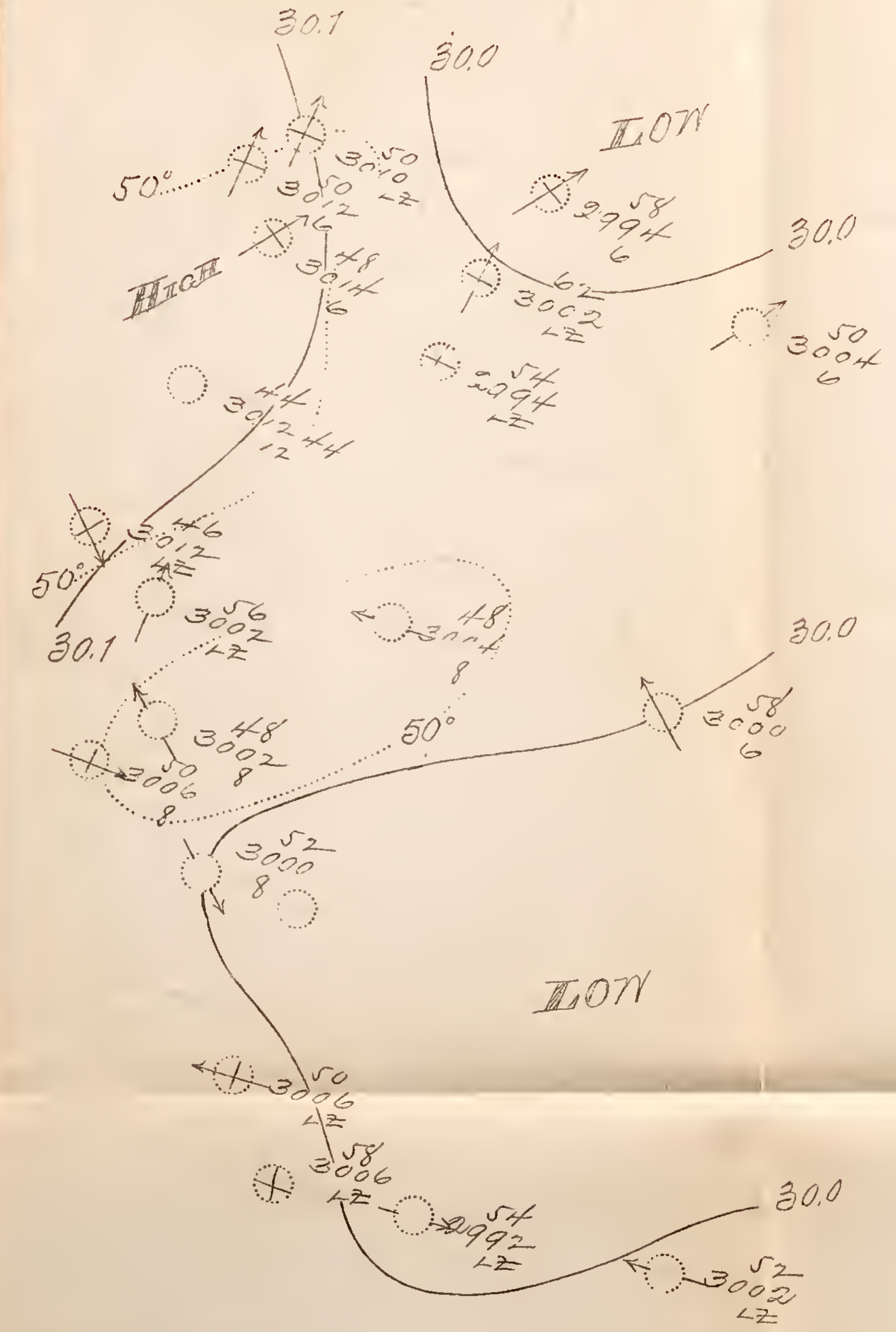
distinctly in sunlight or shadow. The map is outlined in blue, and all other lines, for purposes of division and tabular arrangement, are in white. The entire board is inclosed in a deep molding, painted in black, except a small stripe in light red on the interior portion. The board may be used for displaying either the morning or the evening reports, or both. In using the morning reports the temperature column will show the readings of the minimum thermometer, and, in the case of the evening reports, the readings of the maximum thermometer.

Upon the introduction of this blackboard weather map in San Francisco, decided interest was manifested by the people. Boards were quickly purchased and placed in position at the following named places: Palace Hotel, office of the "Examiner," Produce Exchange, Merchants' Exchange, Board of Trade, Mercantile Lunch, Lick House, California Hotel, and the central offices of the Southern Pacific Railroad Company. The necessary data for preparing the boards are furnished daily from the Signal Office, and at each place a person is especially appointed to care for the board. In some instances considerable artistic skill is shown in drawing the map, all of which is well appreciated by the public, and adds much to the usefulness of the scheme.

THE DAILY WEATHER MAP.

By J. P. Finley, Lieutenant Signal Corps, officer in charge San Francisco Signal Office.

Cartographical representation is indispensable in meteorological investigation. The fact that cyclonic and anti-cyclonic disturbances individually embrace large portions of the earth's surface, and that it is necessary, in studying their development and movements, to require all observations to be made at the same moment of actual time, establishes the imperative need of specially prepared charts, on which the data shall be entered and discussed. By the aid of the chart a birds-eye view is afforded of the entire region from which reports are received. The student must quickly grasp an accurate knowledge of atmospheric conditions over the whole region, as a unit, and not confine his attention to any one small part. Such a comprehensive study affords adequate basis for the preparation of weather forecasts, and is absolutely indispensable to the prosecution of this very important feature of meteorological work. Without the daily map weather forecasts would be impracticable, even for a single locality, as the weather of a place depends upon atmospheric conditions developed several hundred miles to the westward of it, which are gradually progressing eastward. On its first appearance, in February, 1871, at the office of the Chief Signal Officer, Washington, D. C., this important adjunct to a knowledge of practical meteorology was confined to the study room, and the general public knew nothing of its peculiarities and advantages. In 1873 steps were taken to provide for the publication and sale, in a limited manner, of the daily weather map, but this only placed the charts in libraries and scientific institutions. In May, 1879, arrangements were perfected by the Chief Signal Officer whereby the daily map was published, for a



May 16", 1

	Rain-fall			
Stations	past 24 hours	Seasonal to date	Normal May	Min Temp
Spokane	.06	9.21	1.17	58
Helena				46
Olympia		32.11	2.84	50
Port Canby	Trace	47.87	3.16	50
Walla Walla	.10	8.77	2.08	60
Portland		26.03	2.58	48
Baker City	.04	9.78	1.38	54
Roseburg		26.53	1.79	44
Eureka		33.22	3.30	44
Winnemucca	.04	5.33	.78	46
Red Bluff		21.03	.78	54
Salt Lake	.02			54
Carson City			.94	
Sacramento		15.52	.69	48
San Francisco		16.82	.62	48
Fresno		8.25	1.21	52
Keeler		4.44	.41	
Los Angeles		13.09	2.35	48
San Diego		10.03	.44	58
Yuma		6.22	.04	60
Fort Grant		18.13	.27	50

8a May 16", 1

North Cal:- Fair weather, Southwest to northwest winds, nearly stationary temperature except warmer at - Sacramento & Eureka

South Cal:- Fair weather, variable winds generally westerly, nearly stationary temperature except warmer at Los Angeles & cooler at San Diego.

Oregon & Washington:- Light rains except fair - weather in southwestern Oregon, winds generally - Southerly, cooler except nearly stationary temperature at Portland

Forecast

a May 17", 1

Warmer fair weather.

56 49 0

Gray FROM LIEUT. JNO. P. FINLEY, U. S. A. Signal Office, San Francisco, Cal'a.

short space of time, in one of the New York (The Graphic) illustrated papers. The scale was extremely small, and resulted in crowding the weather data to such an extent as to make its reproduction almost unintelligible, thereby defeating the purpose of the work. The data for the map was telegraphed, by means of a special cipher, from Washington to New York, which involved some difficulties that were also instrumental in terminating the publication of the map. Upon its discontinuance in the New York paper several attempts were made, voluntarily, by some of the western papers, to publish portions of the daily weather map, but under different arrangements for receiving the data.

In 1887, at about thirty of the larger Signal Service Stations, the issue of the tri-daily manifold bulletins was replaced by the morning weather map. Telegraphic reports were collected at each of these stations from the region of country which would best serve the commercial interests of the center of publication and distribution. This arrangement would naturally result in the printing of a special map for each station, embracing a particular portion of the United States. The introduction of this change in the method of furnishing weather information, for the use of the general public, met with instant success and hearty appreciation. It was like passing from darkness into sunlight. The monotonous columns of figures on the bulletin were transformed into a novel, graphic, and interesting picture. Quickly the most observant began to comprehend the panoramic view before them—the alternation of areas of rain or snow and fair weather, the areas of high and low barometer, the movement of warm and cold waves, the uniformity of wind direction over vast regions, and the extent and character of general atmospheric disturbances within the region comprised by the chart. The weather map not only gives all this important information, but by a preservation of the files there is afforded a volume for reference which presents a daily photograph of the weather of any region under consideration. As strongly attesting the popularity and usefulness of the weather map, the report of the Chief Signal Officer for 1890 shows that the publication of the daily weather chart at stations of the Signal Service has increased from fifty-two thousand copies in 1887, to eight hundred and seventy-six thousand in 1890, exclusive of the publication at Washington, which increased from one hundred and twenty-six thousand to one hundred and ninety-three thousand during the same period.

During the prolonged effort to secure the daily publication of a weather map for the East, no similar action appears to have been taken for its introduction on the Pacific Coast. Since the opening of the service in 1871, at San Francisco, the manifold bulletin has been the only means of publication and display in the distribution of weather information. The Pacific Coast weather forecasts were begun in 1885, and have been continued regularly thereafter, the means of publication being the small manifold bulletin, and through the newspapers. It appeared to me that the preparation of a special weather map for the Pacific Coast States should not be longer delayed, and I therefore set to work to accomplish the desired result. In August, 1890, I submitted a report, with drawings, to the Chief Signal Officer at Washington, D. C., who finally approved of the scheme. The result is shown in miniature by the accompanying Chart No. I, which displays the weather conditions

in the Pacific Coast States on December 3, 1890. The headings are sufficiently explicit to show the character of the data published on the chart, which is issued twice daily, at 9:30 A. M. and 6:30 P. M. The size of the map is about twelve by fourteen inches. On the charted portion are shown the areas of high and low barometric pressure, barometer and thermometer readings at all stations, precipitation, wind direction and velocity, and the state of weather. At the outset the daily edition was limited to fifty copies, but this may be increased as urgency for the publication is developed. Already much interest has been manifested in this publication by those who have become acquainted with its scope and practical advantages. As the work becomes more generally known and understood on the Pacific Coast, deeper and more intelligent interest will be taken by the people in the daily collection and use of weather information over large areas of country. The weather map, when properly used, will become the means of educating the popular mind to a practical knowledge of weather science. It should become as generally used as the newspaper, and as practical for purposes of information. It should be so well understood that every reader of the map could apply its information to his daily business with advantage. This is not too much to say or expect of the weather map, and the results already accomplished in the East abundantly testify to the high probability of such a future for it.

SOME INFORMATION AS TO THE WORK OF THE BRANCH SIGNAL OFFICE AT SAN FRANCISCO.

By J. P. Finley, Lieutenant Signal Corps, officer in charge San Francisco Signal Office.

The Branch Signal Office was established under orders of the War Department, dated January 6, 1885, and is the only Signal Service Office of its kind in the country. It is the most important office of the United States Weather Bureau outside of the Central Office at Washington, D. C. After careful consideration, it was decided by the Chief Signal Officer that the needs of the Pacific Coast required the opening of such an office, where telegraphic weather reports from a large number of stations could be received several times daily, from a study of which weather forecasts could be made and distributed to the public. It was also deemed advisable to issue special forecasts of rain, high winds, and frosts, and to order the display of cautionary and storm signals, at seaport cities, for the benefit of maritime interests. Since its establishment the Branch Signal Office has been growing in importance yearly, and the people have responded with unfailing support and appreciation. Time and study have clearly shown the wisdom of the Chief Signal Officer in providing for an independent office on the Pacific Coast, from which could issue special predictions for this region, and where opportunity could be afforded for direct and immediate study of meteorological problems affecting a region having peculiarities of atmospheric conditions separating it from the remainder of the country. The distance is so great from the source of central authority

at Washington that, even with the aid of the telegraph, the expense and delay of communication would frequently operate as a serious obstacle in rendering some important service to commercial interests.

The difficulty may be lessened in time by enlarging and increasing the telegraphic service between the East and the West, but at present a thoroughly competent representative of the United States Weather Bureau, with adequate authority to act and advise for the benefit of the public, is certainly required. The people should not only receive benefit from the formal daily forecasts of the weather, but efforts should be made to educate them by proper publications, which will show them how to understand the methods pursued in weather investigation, and how to derive the best results from the information furnished.

The most important work performed at the Branch Office is weather forecasting and the study of the meteorological conditions and other peculiarities of the region for which the forecasts are made. The officer in charge, however, occupies a dual position, in which he not only personally superintends the weather work of the Pacific Coast States, but also has personal charge of the military telegraph lines and cables of the Division of the Pacific. The duties are largely combined as a matter of necessity, because telegraphic communication is maintained over Government lines, between certain points, for the purpose of collecting weather reports, as well as for purely military purposes.

Upon the establishment of the Branch Signal Office the weather forecasts were prepared for special districts, designated as follows: "North Pacific Region," including Oregon and Washington; "Middle Pacific Region," embracing Northern California and western Nevada; "South Pacific Region," embracing Southern California. In July, 1888, this division into regions was changed, and forecasts were ordered made for States, in which the name of the State should be given, and the prediction confined to that area. It was also permitted to designate in the forecasts any particular part of the State, as: "the northeast portion," "extreme northwest portion," "along the coast," "in the interior," etc. While compelling more exactness in the work, this plan also provided for the use of familiar terms in referring to geographical divisions, so that people could more readily apply the information contained in the forecasts. It is probably not generally known that there is a region of country in the United States for which weather forecasts have never been made. It embraces Arizona, New Mexico, Utah, western Colorado, Wyoming, Idaho, and Montana. Although telegraphic weather reports are received from this region, and Signal Service stations have been established there for many years, the commercial and agricultural interests are not sufficiently developed to demand special weather forecasts.

At the Branch Office four weather charts are prepared twice daily, at 9 A. M. and 6 P. M., from a study of which general and special weather forecasts and storm warnings are made. The reports for the preparation of these charts are received from the various Signal Service stations in Arizona, California, Nevada, Oregon, and Washington.

Chart No. 1 shows for each station the current temperature, barometric pressure reduced to sea level, current wind velocity, wind direction, state of weather, precipitation, and maximum wind velocity since last regular report. Isotherms are drawn in blue for each 10 degrees of temperature, in full lines, and, when doubtful, in broken lines. Isobars are drawn in red for each tenth of an inch of barometric pressure, in full

lines; when doubtful, in broken lines, and designated by the proper unit and tenth. The words "high" or "low" are so placed as to show the relative barometric condition of the regions marked.

Chart No. 2 shows for each station the twelve and twenty-four-hour changes in barometric pressure, the differences being expressed decimally with the algebraic signs of plus and minus. The departure from the normal is also shown for each station in the manner above indicated. Lines in blue, drawn for each tenth of an inch, represent the twelve-hour changes, and those in red the twenty-four-hour changes. Lines in black may be used to indicate the plus and minus changes from the normal barometric pressure.

Chart No. 3 shows for each station the twelve and twenty-four-hour changes in temperature; also, the departures from the normal temperature. Lines in blue, drawn for each 10 degrees of temperature, represent the twelve-hour changes, and those in red the twenty-four-hour changes. Lines in black may be used to indicate the plus and minus changes from the normal temperature at each station.

Chart No. 4 shows for each station the minimum temperature at the morning report, and the maximum temperature at the evening report; the kind and extent of clouds, both upper and lower; the dew point; the twenty-four-hour change in minimum temperature, and the twenty-four-hour change in maximum temperature. Lines in red represent the temperature changes for each 10 degrees.

The weather forecasts embrace general forecasts for each State, special forecasts for localities, and storm warnings for the benefit of shipping at coast cities. The special forecasts consist of rain warnings, frost warnings, and forecasts of weather and temperature. Any town or city is entitled to receive these special predictions by telegraph at Government expense, providing the weather and temperature flags of the Signal Service are furnished and displayed for the benefit of the public. In some instances newspapers have been furnished the forecasts at Government expense by providing cuts of the signal flags and printing them with the telegraphic message in their daily issue. This is considered almost equivalent to displaying the flags. Individuals can receive the telegraphic forecasts for their *personal* use on payment of the cost of the telegram. Besides the preparation of the general weather forecasts for States, made twice daily, special forecasts are sent daily to fifty different places in the Pacific Coast States. Storm warnings are furnished to seven stations in California, Oregon, and Washington. Special rain warnings are furnished during the raisin-making season to fifteen places in California. These warnings prove of much practical value, and many testimonials have been received at the Branch Office announcing this fact and the appreciation of the public.

The following changes and improvements have been effected at the Branch Signal Office by the present officer, Lieutenant Finley, since he assumed charge in July, 1890:

First—The combination of the observer's office with the Branch Office, and the establishment of one general office in more commodious quarters, which are better adapted to the work of the Service. By this change an excellent exposure is obtained for the instruments, and all are collected together on one platform, made easy of access, so as to delay the observer as little as possible in taking his observations. At the old station in the Merchants' Exchange the instruments were very

much scattered about the roof and tower of the building, and no change of any importance had been made in twenty years. The present location of the general office, in the Phelan Building, affords many advantages, not the least of which relate to the instruments, their elevation having been increased over fifty feet, and altogether made much more convenient of access. The combination of the two offices has resulted in the accomplishment of more work and better service to the public.

Second—The classification and binding of the large accumulation of records, making them much more accessible for study and the use of the public.

Third—The preparation of a special daily weather map of the Pacific Coast States, to be printed daily for the use of the public, at Government expense.

Fourth—The preparation of a blackboard weather map to display the daily weather conditions of the Pacific Coast States, for the benefit of commercial and maritime interests in San Francisco.

Fifth—The adoption of a local rain signal for the use of the fruit industry of California. This new signal is of the same size as the other weather flags, but the colors are arranged to make it half blue and half white, and thus indicate light rain or showers. The blue flag indicates rain or heavy rain, and the white flag fair weather. It was very important, especially to those engaged in making raisins, that distinction should be made in the weather signals, so that a light rain or passing shower could be distinguished from a heavy or continuous rain.

Sixth—Securing the coöperation of the press of the Pacific Coast States in publishing the reports of the Branch Signal Office, and in furnishing copies of their papers to aid in the collection of local meteorological data not within reach of the regular Signal Service stations. Over one hundred and fifty papers responded to this invitation, coming from Arizona, California, Nevada, Oregon, Washington, and Idaho. Most of these papers are published daily, and thus the collection at the Branch Office is very large and exhaustive. An examination of this immense mass of printed matter shows a constantly increasing interest in weather science, and a most encouraging growth in a knowledge of how to apply and make the best use of the large amount of weather information collected and distributed by the General Government and State organizations.

Seventh—Increasing the scope and augmenting the distribution of the monthly weather review issued by the Branch Signal Office. The number of copies published has increased from twenty to nearly two hundred per month. The review is published by the press throughout the Pacific Coast States.

Eighth—Connecting the Branch Signal Office by long distance telephone with all parts of California reached by these instruments, through the San Francisco Central Telephone Office. This arrangement was made to aid in the distribution of weather forecasts outside of San Francisco, for the benefit of the public, and was effected through the courtesy of the Pacific Telephone and Telegraph Company, which organization agreed to coöperate with the Signal Service in distributing weather forecasts in California.

Ninth—Connecting Point Reyes Lighthouse, Cal., direct with the Branch Signal Office, so as to furnish vessel and weather reports from that station to the Merchants' Exchange of San Francisco, with the

least possible delay. This arrangement has been of great service in furnishing prompt reports of vessels in distress, and securing assistance for them, saving both life and property. A notable instance was the rescue of the British ship Jessomene, with the entire crew, during the storm of February 22, 1891, near Point Bonita, California. She was valued at $200,000.

Tenth—Connecting the Branch Signal Office by telegraph, through the Western Union, with all parts of the Pacific Coast, and thus providing the means of receiving, by wire, at the Signal Office the weather reports from all Signal Service stations. This arrangement aids materially in the preparation of the daily forecasts.

Eleventh—Connecting the Branch Signal Office with the Postal Union Telegraph Company, so as to receive by wire special weather reports from their agents at over twenty places in Oregon and California. These reports are received each morning at 8:30 A. M., and are used in furnishing special rain data to the public.

Twelfth—Arranging with the officials of the Southern Pacific Railroad Company to receive their morning weather report by 9 A. M., from over one hundred stations in Nevada, California, and Arizona. The information thus gathered is furnished in various ways to the public.

Thirteenth—Arrangements made to furnish special weather forecasts by telephone to about twenty places in San Francisco.

Fourteenth—Arrangements perfected to connect by telegraph lines and cables all the military posts in and about San Francisco with the Branch Signal Office, thus establishing communication between the posts in the harbor, and those on the mainland, with army headquarters.

Fifteenth—The issue of special weather bulletins to the press in the event of unusual meteorological conditions existing in the Pacific Coast States. These bulletins afford explanations and more detailed information than can be given in the regular synopsis and forecasts.

Sixteenth—The issue of circulars to the press for the purpose of explaining the use of technical meteorological terms, and to describe the character of various meteorological phenomena, especially those peculiar to the meteorology and climatology of the Pacific Coast. The object of these circulars is to furnish information to the public which will better enable them to make practical use of the weather information distributed by the Government.

METEOROLOGICAL BULLETINS.

By J. P. Finley, Lieutenant Signal Corps, officer in charge San Francisco Signal Office.

In view of the many inquires received at this office relative to the use and significance of technical meteorological terms, and for information as to the character of the various forms of atmospheric disturbances recognized by the science of meteorology, it has been deemed advisable to prepare for publication, through the press, a series of circulars or bulletins which will briefly, but yet comprehensively, furnish the desired data. It is believed that this plan will serve to instruct the public on an important subject, and assist in making the daily weather forecast of more practical value.

BULLETIN No. I.

The Cyclone.

Signal Service U. S. Army, Division of the Pacific,
San Francisco, Cal., January 27, 1891.

About fifty years ago, Piddington, of Calcutta, East India, first applied the term "cyclone" to all circular storms of whatever area. The word comes from the Greek "cyclos," which signifies, among other things, the coil of a snake. Its application to the most important of all meteorological disturbances is not intended to affirm that the area described by the storm is a true circle, but rather expressing sufficiently the tendency of the air to a circulatory motion. The word is now accepted by the leading meteorologists of the world as properly distinguishing a certain and well defined class of atmospheric phenomena.

The cyclone is a broad disturbance, having a diameter of from three hundred to five hundred miles, and sometimes one thousand miles. It is a vast eddy in the atmosphere, and moves along in that medium very much as the eddies in a stream of water. The air does not have an actual circular motion at any place within the disturbed area, but only a tendency to spiral movement. Even this tendency is not revealed by reports from a single station. It is necessary to obtain observations from the entire area of disturbance, which, when platted on a chart, disclose the general movement of the air, gradually inward toward the center, where it rises to the upper cloud region and flows outward on all sides. This motion of the air gives rise to westerly winds south of a cyclonic center, southerly winds on the east, easterly winds on the north, and northerly winds on the west. At the center of the area there is a calm space ten or fifteen miles in diameter, known as the "eye of the storm." This is a very dangerous part of the cyclone for vessels to encounter, as they become motionless and are then suddenly caught at a disadvantage by the rear of the storm. The barometer is lowest at the center and increases in height outward to the circumference. The form of the cyclonic area is either circular or elliptical, generally the latter. The direction of progressive movement is from west to east, under the influence of the rotation of the earth, and while not directly visible, is apparent in the passing changes of the weather. The rate of movement is, on the average, about thirty miles per hour, being most rapid in winter, with a maximum of fifty miles, and least rapid in summer, with a minimum of about ten miles.

The four quadrants of a cyclone have distinct and invariable characteristics, as follows: In the northeast quadrant, great humidity, high winds, precipitation, and heavy clouds, especially in the southern portion. In the southeast quadrant, the maximum of heat and moisture, and the region of all classes of local storms, especially the "tornado." In the southwest quadrant, clearing weather, with dashes of rain in the eastern portion, falling temperature, and diminishing humidity. In the northwest quadrant, the minimum of heat and moisture, general absence of clouds, and brisk, cold winds. Some cyclones may preserve their identity in passing entirely around the earth, but the generality only make about one third of that distance, and then disappear in the general circulation of the atmosphere.

The words "gale," "storm," "hurricane," "tempest," "typhoon,"

"breeze," etc., define the *strength* of the wind in a cyclone, but do not describe the general disturbance which gives rise to rain, clouds, winds, atmospheric electricity, and variable conditions of heat and moisture. This great disturbance, having a well defined area, direction of movement, and velocity of progression, is properly known as a cyclone.

The following scale shows that the above terms relate to the power of the wind, and should not be employed to designate a general disturbance like the cyclone and anti-cyclone:

SIGNAL SERVICE SCALE OF THE FORCE OF THE WIND.

Calm, 0. No visible horizontal motion to inanimate matter.
Light, 1 to 2 miles. Causes smoke to move from the vertical.
Gentle, 3 to 5 miles. Moves leaves of trees.
Fresh, 6 to 14 miles. Moves small branches, and blows up dust.
Brisk, 15 to 24 miles. Good sailing breeze, and makes white caps.
High, 25 to 39 miles. Sways trees, and breaks branches.
Gale, 40 to 59 miles. Dangerous for sailing vessels.
Storm, 60 to 79 miles. Prostrates exposed trees and frail houses.
Hurricane, tempest, or typhoon, 80 or more miles. Prostrates everything.

BULLETIN No. II.

THE ANTI-CYCLONE.

BRANCH SIGNAL OFFICE,
SAN FRANCISCO, CAL., February 10, 1891.

The employment of this term for meteorological purposes naturally follows the use of the word cyclone. The prefix "anti" indicates the existence of a circulatory system in the air directly contrary to that which prevails in the cyclone. As the circulation of the air currents differs widely from those of the cyclone, so also are the accessory phenomena of an opposite nature. The anti-cyclone is an area of high barometer, in which the atmospheric pressure is decidedly above the normal. The highest pressure is at the center, and diminishes thence outward to the circumference. The circulation of the air is spirally outward from the center. The air does not attain a circular motion anywhere within the area, and the tendency to a spiral movement is only disclosed when the whole disturbance is charted and observations from every quarter are available. The circulation of the air in an anti-cyclone gives rise to westerly winds on the north side of the center, northerly winds on the east side, easterly winds on the south side, and southerly winds on the west side. The four quadrants of an anti-cyclone are distinguished as follows: In the northeast quadrant, clear, cold, dry weather, with winds of moderate force. In the southeast quadrant a cold wave, with the lowest temperature, clear, dry air, and high winds. In the southwest quadrant, fair, cool, pleasant weather, with gentle winds and haze. In the northwest quadrant, increasing temperature, increasing humidity, cloud formation, and threatening weather.

The front of an anti-cyclone is the extreme rear of a cyclone, and the extreme rear of an anti-cyclone is the front of a cyclone. The air moves downward and outward in an anti-cyclone, and inward and upward in a cyclone. The air which flows outward from the top of a cyclone is cold and dry, because deprived of its heat and moisture in the development

of rain or snow. This air descends toward the earth's surface and gives rise to the formation of the anti-cyclone. There is always an anti-cyclone between two cyclones, both of which are feeding the former and maintaining its identity. The cold weather of an anti-cyclone is partly due to the descent of cold air from above, the horizontal flow of cold air from northern regions, and the effect of radiation, which is greatly augmented by the absence of vapor and clouds. The area of the anti-cyclone is frequently greater than that of the cyclone, and its form less regular. Anti-cyclone is synonymous with clear, cool weather, moderate winds, and a cold wave; and cyclone, with cloudy weather, rain or snow, high winds, and a warm wave. The word "high" on the weather map indicates the area of an anti-cyclone, and the word "low" the area of a cyclone. Both disturbances are beneficial and necessary to the prosperity of mankind.

BULLETIN No. III.

The Tornado.

Signal Service U. S. Army, Division of the Pacific,
San Francisco, Cal., February 26, 1891.

This storm is the most violent and destructive of all atmospheric disturbances. The derivation of the term has peculiar significance. The Latin word is *tornare*, to turn, or in other words, a whirling wind. The Spanish and also the Portuguese term is *tornada*, which means to return, or turn upon itself. An effort appears to have been made to coin a word that would convey the idea of a small whirling, cylindrical cloud, accompanied with much violence. The word tornado has no uncertain derivation. About three centuries ago it possessed practically the same meaning that it has to-day. Over two hundred years ago British seamen reported their experiences with tornadoes (waterspouts) off the northwest coast of Africa. From the knowledge acquired by these early seamen we trace the use of the word tornado to England and thence to the English colonies in America. As early as 1682 we find the record of a tornado at New Haven, Conn., June tenth, at 2:30 p. m. A minute and very interesting description was prepared and preserved of its peculiar features, which reads as if the storm occurred but yesterday. The conditions of tornado development are: (1) An unstable state of the atmosphere which occurs in the cloud regions; (2) the opposing movement of warm, moist, and cold, dry air currents, the latter overflowing the former; (3) the existence of a gyratory motion in the air relative to some central point.

The regions most favorable for the occurrence of tornadoes are the Mississippi, Missouri, and Ohio Valleys, and the Gulf and South Atlantic States. Tornadoes are confined almost entirely to the summer season, the months of greatest frequency being April, May, June, and July. The month of greatest frequency is May. It may be generally stated that tornadoes do not occur in the United States west of the one hundredth meridian. This storm is practically unknown in California. The tornado invariably assumes the form of a funnel-shaped cloud, the smaller end drawing near to or resting upon the earth. The cloud and the air beneath it revolve about a central vertical axis with incon-

ceivable rapidity, and always in a direction contrary to the movement of the hands of a clock. The average width of the path of destruction is about eighty rods. The wind velocities of the tornado cloud vary from one hundred to eight hundred miles per hour. The tornado almost invariably occurs in the afternoon, just after the hottest part of the day. The hours of greatest frequency are from 3 to 5 P. M. A tornado passing over a body of water gives rise to what is called a water-spout. No building, however constructed, can resist the violent incurving and uplifting winds of the tornado's vortex. The average length of a tornado's path is about twenty-five miles. The general direction of movement is from southwest to northeast. The tornado is a purely local storm, and always destructive.

BULLETIN No. IV.

Some Important Facts about the Climate of Oregon and Washington.

Signal Service U. S. Army, Division of the Pacific,
San Francisco, Cal., March 11, 1891.

The geographical position of these two States is a most fortunate one. Located in the latitude of the easterly trend of the central portion of the Japan current, they receive the full benefit of the warmth and moisture continually rising from this great stream. The atmospheric eddies, or areas of low barometric pressure forming over the Japan current, enter the continent throughout the year in a manner to provide a most equable distribution of rain. The relation of the two great States to the Japan current is one of vital importance to their commercial and agricultural interests, and should be clearly understood by the people. Reverse the direction of this current so that its motion in the equatorial regions becomes westerly, and in the temperate zone easterly, and shift its latitude a few degrees to the south, and the North Pacific Coast States would become as barren and bleak as northern Canada and Labrador. How great a factor, then, in the development of a country, is the supply of heat and moisture.

The following is a brief summary of the atmospheric effects of the Japan current on the climate of the North Pacific region:

1. A general equability of temperature unequaled in any other portion of the United States.

2. A gradual change from the heavier rains of winter to the lighter rains of summer, giving rise to a most beneficial distribution of precipitation throughout the year.

3. In winter the atmospheric disturbances from the Japan current move eastward at a lower latitude than in summer, and this shifting north and south of the storm centers makes the difference in rainfall between the two seasons. But as the change of the centers is not very great respecting Oregon and Washington, these States are always within the area of precipitation accompanying the low-pressure areas.

4. A prolific growth of all forms of plant life.

5. Climatic conditions which favor to a marked extent the growth of most cereals and other important staple crops.

6. The alternation of rain and fair weather in such a manner as to provide most suitable conditions for planting and harvesting.

7. The absence of excessively violent storms, owing to the southwest deflection of the Japan current at the parallel of 45 degrees north; the cold Alaskan current along the California coast, and the dry atmosphere of the Middle Plateau region.

8. Computed from the records of nearly twenty stations, covering a long series of years, the percentage of rainfall in Washington varies from 2.05 per cent in August to 15.70 per cent in January.

9. Computed from the records of twenty stations, covering a long series of years, the percentage of rainfall in Oregon varies from 1.25 per cent in August to 17.10 per cent in December.

BULLETIN No. V.

Some Facts about Weather Forecasts.

Signal Service U. S. Army, Division of the Pacific,
San Francisco, Cal., March 18, 1891.

The Branch Office of the National Weather Service, Division of the Pacific, was opened at San Francisco, March 1, 1885, and is the only office of its kind in the country outside of the Central Office at Washington, D. C. It was established for the purpose of providing, in the most direct and practical manner, an opportunity for the people of the Pacific Coast to receive all of the benefits that should be derived from the work of the Signal Service. The main object was to prepare and distribute, through the press and by telegraph, weather forecasts for the Pacific Coast States, and warn vessels of the approach of storms dangerous to shipping off the coast; also, to make special forecasts of rain, frosts, floods, and local storms. Such work had been carried on at the Central Office in Washington many years, for the eastern portion of the United States, and it was believed that the time had come for the organization of a Pacific Coast Weather Service, with headquarters at the metropolis of the coast, and at a place centrally located, for the convenient receipt and distribution of telegraphic reports.

To properly apply the weather forecasts to definite areas of country, the Pacific Coast was divided into three districts, designated officially, as follows: North Pacific Region, embracing western Oregon and western Washington; Middle Pacific Region, embracing the western portion of California north of parallel 37 degrees north, or an east and west line cutting the northern edge of the bay of Monterey; South Pacific Region, embracing the western portion of California south of parallel 37 degrees north.

On May 1, 1886, an order was issued from Washington changing the districts to State areas, and thereafter the weather forecasts were made for the following regions: Washington, embracing the entire State; Oregon, embracing the entire State; Northern California, embracing that portion of the State north of the latitude of 36 degrees, or an east and west line passing through the central portion of Lake Tulare; Southern California, embracing that portion of the State south of the latitude of 36 degrees north.

There have been several changes in the hours at which the forecasts have been prepared for issue, dependent upon the hours of meteorological observation and the convenience of the press. Observations are now taken throughout the United States at 8 A. M. and at 8 P. M., seventy-fifth meridian time, which corresponds to 5 A. M. and 5 P. M., Pacific time. The weather forecasts are issued from the San Francisco office about 9:30 A. M. and 6:30 P. M. daily. An earlier hour cannot easily be selected, because of the want of telegraphic facilities in concentrating the reports at San Francisco, from all parts of the Pacific Coast States. The language of the forecasts must largely conform to the official instructions issued from the Central Office at Washington, which aim to secure brevity and avoid ambiguity.

Forecasts of higher or lower temperature are made each morning with reference to the expected minimum temperature of the following morning, and each evening with reference to the maximum temperature expected on the following afternoon. The forecasts of stationary temperature indicate a change of 4 degrees or less, from March to October, inclusive, and 6 degrees or less for the remaining months of the year. In the case of higher or lower temperature, a change of 1 degree or more is sufficient to verify the forecast. A cold wave, in general terms, is defined to be a fall in temperature, over an extensive area, of 20 degrees in twenty-four hours, or 28 degrees in forty-eight hours, and to the freezing point or below. Warnings of cold waves are issued when it is expected that the area affected will exceed one hundred thousand square miles in extent, and in well defined cases for a lesser area. Forecasts of fair weather mean an entire absence of rainfall, but not necessarily an absence of clouds. Forecasts are usually made for a period of twenty-four hours, but whenever the meteorological conditions are so decided as to dominate the present and are expected to materially modify coming weather over any extensive part of the country, forecasts may be made for periods of thirty-six, forty-eight, and seventy-two hours.

Generally speaking, it is more difficult to forecast, accurately, the weather of summer than that of winter, because of the absence in the former season of well defined storm centers, most of the precipitation being the result of local changes in temperature and wind direction. For a similar reason it is more difficult to forecast the changes of a moderate storm than of those which attend a severe one; because in the latter case the laws of cyclonic development and movement are more closely adhered to, which permits the principles of weather forecasting to be applied with greater success.

LITTLE DROPS OF DEW.

A THEORY OF THEIR ORIGIN, AND OTHER FACTS.

By A. K. Bartlett.

To the ancient philosophers the appearance of dew and frost was a complete mystery, and numerous were the theories advanced, by those

scientifically inclined, to account for their production, and the interesting phenomena they presented. Many, it is said, believed that the dew was nothing else than the tears shed by the Almighty upon our earth, and they regarded it as a sacred substance that possessed a number of wonderful and inexplicable properties. They also attributed to it many strange events and curious manifestations that occurred in those times, and some rubbed it over their bodies in order to protect themselves from the evil spirit, whose malignant influence was held responsible for all the marvelous and unaccountable operations of nature observed on the earth and in the heavens above.

Among all the numerous "truths stranger than fiction" that the study of natural science has revealed, there are few more interesting and instructive than those relating to the phenomena of dew and frost.

The late Prof. J. Dorman Steele, in his excellent work, "Fourteen Weeks in Physics," says: "Dew was anciently thought to possess many wonderful properties. Baths in this precious liquid were said to conduce greatly to beauty. It was collected for this purpose and for the use of the alchemists in their weird experiments, by spreading fleeces of wool upon the ground. Laurens, a philosopher of the middle ages, claimed that dew was ethereal, so that if we should fill a lark's egg with it and lay it out in the sun, immediately on the rising of that luminary the egg would fly off into the air! This experiment is best performed with a goose's egg."

There is considerable misapprehension among the general public concerning the nature and origin of dew and frost, it being commonly supposed by the great majority of people that dew actually falls from the sky, and how frequently do we hear the expression "the dew is falling fast." The fact is, dew never falls, but is formed on the surface of the earth, and always at the identical place where it is seen by the observer. Dew is simply the moisture of the air condensed by coming in contact with objects upon the ground that are colder than itself. The earth, heated during the day by the sun's rays, at night cools off and radiates a considerable portion of its heat into space. All bodies, left to themselves, will gradually become cool if previously heated. This is termed in natural philosophy, radiation, and it may be easily demonstrated by experiment. Take an iron ball, for instance, heat it to incandescence, or until it becomes red hot, and then suspend it by a wire. In a little while it will part with all its heat, and feel quite cool to the touch. The heat has been thrown off, as it were, or radiated, and not carried away by the surrounding air, for precisely the same effect will be produced if this experiment be perfected in a vacuum. Our earth is constantly radiating its heat, like the imaginary ball, in all directions, and at night becomes so cool that the invisible vapor resting upon its surface is condensed into water and deposited as "dew." The temperature at which this takes place is called the "dew point," as indicated by an accurate and reliable thermometer. But this point is by no means constant or invariable, since dew is deposited only when the air is saturated with vapor; and the amount of moisture required to saturate air of high temperature is much greater than for air of low temperature.

All bodies have not the same capacity for radiating heat, but some cool much more rapidly than others. Hence, with the same exposure, some bodies will be covered densely with dew, while others will remain perfectly dry. Dark objects have more dew deposited upon them than

light ones, because they are better radiators, and, therefore, part with a larger amount of heat. This fact may also be demonstrated by placing a black woolen cloth and a white linen or cotton one upon the ground over night. Grass, the leaves of trees, wood, etc., radiate heat very freely; but polished metals, smooth stones, and cotton cloth part with their heat more slowly, so that the former of these substances will be completely drenched with dew, while the latter, in the same situation, will be comparatively dry.

The amount of dew formed in any night is greatly influenced by the condition of the atmosphere. More dew is formed on clear evenings than when the sky is obscured by clouds, because they act as a shield, and reflect back the heat radiated by the earth into space, besides furnishing that received by them during the day, which prevents the earth from cooling off enough to produce a large deposit of dew. But when the sky is free from clouds the earth radiates a larger amount of heat, as there is nothing to intercept that thrown off from its surface. This is the reason why we always have colder nights when no clouds obscure the sky.

The formation of dew is prevented by a strong breeze, which removes the layers of moisture resting upon the ground before they have time to cool down to the "dew point." A slight breeze, however, is favorable to the production of dew, as it replaces the layer of air from which water has been deposited by another containing more moisture. No dew may ever be expected when the sky is obscured by clouds, or when there is a strong wind.

The moisture that appears on the outside of a pitcher when it contains very cold water is nothing but dew, and is produced by the same cause explained above. This dampness frequently observed upon a cold pitcher, even during the hottest weather in summer, is commonly referred to by saying "the pitcher is sweating;" and in this simple illustration we are permitted to recognize, before our eyes, on a small scale, the same interesting process of dew formation that takes place over the surface of the great earth.

HOW CLIMATES CHANGE.

RECORDS QUOTED TO SHOW THAT THE EARTH'S HEAT INCREASES.

By W. H. H. Murray.

It is a matter of knowledge to many that the summers are longer—as measured by the heated term—and the winters warmer than they were a half century ago, and that this result has been reached by slowly but surely operating causes, and this slow but sure change in the climate of the country is one of momentous interest, not only to the naturalist, but to the average citizen as well, for should it continue, vast changes would follow in the industries and products of the country, as well as in its hygienic conditions.

It would not be an unprecedented experience if the northern half of the American continent was passing through a climatic change of so

positive a sort as to become memorable in the history of the globe. For while scientific observation and records are of too recent a period to supply us with adequate data for intelligent judgment as to it, nevertheless literature is filled with evidence bearing directly upon the point, and so implicit in its nature and so emphatic in its iteration as to be unimpeachable. As most Americans are too busy to know much of the past, it may be interesting should we recall a few of the passages in enforcement of our suggestion or surmise.

IN PALESTINE AND ITALY.

The land of Palestine is certainly not to-day a wintry country. But thirty or more centuries ago an ancient poet wrote: "Hast thou entered into the treasures of the snow? Or hast thou seen the treasures of the hail? Out of whose womb came the ice and the hoary frost of heaven; who hath gendered it? The waters are hidden as with a solid rock, and the face of the deep is frozen." Such, evidently, was the degree and effect of the cold in the land of the Midianites thirty centuries ago. And David, writing several centuries later, gives the following description of intense winter weather: "He giveth snow like wool. He scattereth the hoar frost like ashes. He casteth forth his ice like morsels. Who can stand before his cold?" Such is the account of the climate in the land of Palestine twenty-eight and thirty centuries ago.

But instead of snow, hail, ice with the solidity of rock, and frozen sea, the inhabitants of that country to-day live in a hot, sultry climate, in which snow and ice are never seen.

The climate of Italy, as it was of old time, and the great change which has come to it, are not beyond the student's knowledge. Virgil was both a poet and a skilled agriculturist. And in his "Georgics" he often gives directions for the security of young cattle against the dangerous effects of ice and snow and periods of intensely cold weather. His directions were for the neighborhood of Mantua and Naples, and when speaking of Calabria, the most southern and hottest part of Italy, he alludes to the freezing of the larger rivers and streams as a thing to be annually expected.

Nor does he stand alone in his witness as to this matter, for Pliny, Juvenal, and other authors of their time, speak of ice and snow as prevalent in all parts of Italy, while Ælian, if we remember correctly, devotes a whole chapter to the giving of specific directions of how to fish for eels when the rivers are covered with ice. These descriptions of Italian climate apply to it as it was eighteen centuries ago.

Ovid can be quoted in this connection also. We are writing from memory and with less fullness than we might, could we turn to the author's books, but should any classicist be interested to follow us he will find that our recollection is essentially correct. This poet was banished from Italy to Tomas by the Emperor. This place is near the coast of the Euxine Sea, and climatically includes the region round about Constantinople. He spent seven years in exile in this region, and he tells us that he saw the Euxine, or Black Sea, covered with ice; that this ice was not only strong enough to support men, but oxen and heavy sleds loaded with products. He states, moreover, that the wine of the country was often frozen, and that the snow in many places in the forest was never fully melted during the entire summer. It is a

well established fact that in the year 401 the Euxine Sea was frozen over for twenty days together. This is certainly a most extraordinary picture to one who has lived in this century in Constantinople or has knowledge of its climate.

CHANGES IN GERMANY'S CLIMATE.

The Alps and Apennines are the highest of European mountains. History has no stranger tale to tell than the march of Hannibal's army over these lofty ranges. It was one of the wonders of antiquity. Livy and Polybius both bear repeated testimony to the sufferings of his troops from the terrible cold they encountered, and the awful obstacles of the snow and ice. But these mountains are easily passed to-day, for the old time conditions connected with the severity of the climate do not now exist.

Nor have the changes in the climate of Germany been less remarkable. A Latin historian records that in Cæsar's time the Rhine and the Danube were not only frequently frozen, but so deeply frozen that the ice was able to uphold, without cracking, the heaviest of weights. He says that the barbarians—the native Germans—chose the winter season for their campaigns, because they could then transport their armies, cavalry, and heavy wagons along those rivers over a solid bridge of ice.

We might easily continue these quotations from the ancient authors in witness that the climate of both Asia and Europe has undergone a vast change in the last two thousand or three thousand years; a change so profound that it has affected both the character and habits of the people and the products of these countries; a change which amounts to one degree for each hundred years; but we have suggested enough to give direction to the popular thought touching a probable change of the climate in our own country. May it not be that the same causes which operated to modify the climate of the East are now at work changing that of this western hemisphere, and that within one thousand or two thousand years the palm and the date tree will be growing in the valleys of the Connecticut and the Merrimac, and the pomegranate blossom on the shores of Lake Champlain, while the Adirondacks and the White Mountains shall be covered with the olive? May it not be that the American of the future shall spend his summers under the orange groves of New Hampshire, and the inhabitants of Quebec shall ship us our tea as they pick it in the slopes of the Laurentian hills? Verily, who may foretell the changes that may come if the world will only go on getting hotter and hotter.

RAIN AND SNOW.

[Greeley's "American Weather."]

Rainfall is the most indefinite of the various meteorological phenomena, as to its locality, distribution, seasonal recurrence, and amount. It is impossible to draw a sharp line between mist and rain. Whenever condensation of aqueous vapor takes place rapidly and the small particles of mist increase in diameter it is then called rain. The exact man-

ner in which rain forms is not known. Different theories have been advanced, some assuming that two masses of saturated air of different temperatures are suddenly combined, with the result of immediately condensing the excess of moisture which necessarily results. Others urge that rainfall usually occurs by the cold of expansion or elevation, owing to large masses of saturated air being forced upward by under-running currents of cold air, or by violent out-draughts of warm air from the upper strata of the atmosphere, which naturally draw upward the saturated air. Doubtless both methods obtain to a greater or less extent, and it is susceptible of proof that the heaviest rains of the world are caused by the cold of expansion, where the general movements of the atmosphere result in warm, moist air being forced or drawn up to great elevations by the presence of abrupt mountain ranges, over which the air must pass, and in so doing lose the greater part of its vapor. The author believes in the general law advanced by Blanford, that "however vapor laden may be any current of air, however saturated, it does not bring rainfall so long as it preserves a horizontal movement." Either increased elevation, or eddies from increase of friction, or the convection around borders of a barometric depression, causes formation of clouds and rain.

Excessive rainfall on land occurs at places in middle or lower latitudes contiguous to a sea of comparatively high mean temperature and from which the prevailing winds blow. The heavy rain results from the condensation of moisture by cold, caused, as some suggest, partly by the winds passing over a land of lower temperature, or, as is more probable, by being forced upward, more or less sharply, by the configuration of the country.

The author, from a somewhat extensive observation of weather conditions, fails to find any cases where the vapor-laden air is apparently cooled to any extent by radiation or convection from land of low temperature. The process of cooling a body of moist air by its own radiation into space, or by convection or radiation from cold land, must be very slow, and the final effect inconsiderable; especially as compared with the cold of elevation, which is about half a degree for every hundred feet of ascent.

Deficient rainfall over land occurs in high latitudes, where the mean temperature of sea and air are both low. In low latitudes it results from the prevalent winds having been deprived of the greater part of their moisture by having passed over mountain ranges of considerable elevation, or by their passing over a country having nearly the same temperature as the region from which the moisture was drawn, and where the country does not rise with marked abruptness. Tranquil atmospheric conditions arising from the absence of low areas, or exemption from their influence owing to intervening and obstructing mountain ranges, tend greatly to reduce the amount of rainfall.

Rain or snow from a cloudless sky sometimes occur, and is called *serein;* it is nearly always small. Buchan cites a case from the experience of Sir J. C. Ross (the famous Arctic traveler), on Christmas day, 1839, near Trinidad, when a light shower of nearly an hour prevailed without a cloud in sight. Similar cases have not been infrequent in the United States, where over twenty have been observed. It is often suggested that the rainfall may be from thin and translucent clouds.

Prof. T. Russell, in examining nearly one hundred cases of rain and snow from a clear sky, found that the larger number occur "on the southwest side of an area of low barometer, * * * at a distance of about five hundred miles from its center." Frequently high winds prevail, so that the snow could be carried from a cloudy region in the upper air.

On June 30, 1877, a heavy shower at Vevay, Indiana, lasting five minutes, fell from an apparently cloudless sky. The raindrops were of large size, and, as caught on a sheet of blotting paper, made circles two and a half inches in diameter. Nearly three fourths of an inch of snow fell from a clear sky on March 15, 1885, at Bloomington, Illinois.

In the experience of the author at Fort Conger, Grinnell Land, 81° 44′ north, snow or frost fell almost daily during the prolonged cold spells in mid-winter, when spiculæ of frost appeared to be continually in suspension in mid-air. This snowfall and frost phenomena were attributed to the solid condensation of the aqueous vapor of the comparatively warm upper air by the layers being successively chilled, partly by radiation and partly by contact with the cold underlying strata. It was invariably the case during prolonged cold that the upper strata of air, as shown by observations on adjacent mountains, were always warmer than at the bases.

There are occasional instances in which black, yellow, or golden rain are reported, as well as showers containing fish and animalculæ and insects of various kinds. In all these cases the foreign constituents and color of the rain or snow are due to impurities gathered from the surface of the earth.

In March, 1879, several instances of yellow rain or snow occurred in the United States. At South Bethlehem, Penn., during the night of March sixteenth there was a slight fall of snow in that section, and on the next morning, when the snow had melted, a yellow deposit was found covering the ground, more or less. Upon examination the deposit was found to be the pollen of pine trees. The Signal Corps observer at New Orleans reported light showers on the seventeenth, and stated that "a peculiar feature of the rain was its yellow color, which was due to large quantities of the pollen of the cypress trees floating in the atmosphere." At Lynchburg, Va., yellow rain fell on March 21, 1879, a sample of which was transmitted to the Surgeon-General, United States Army, for microscopical examination. Major J. J. Woodward, Surgeon United States Army, reported that "the yellow powder which gives it its physical properties consists entirely of the characteristic triple-grained pollen of the pine. The pine woods in the region around Lynchburg had been in blossom, I believe, for some days previous to the twentieth, and the direction of the wind at the time should indicate where the pollen came from. Under favorable circumstances, however, the pollen may be carried for long distances, so that its source is not necessarily near the town."

Professor Weber gives an account of golden snow on February 27, 1877, in Peckeloh, Germany. He says: "The snow did not appear white but yellow, and a kind of yellow which gave the appearance of a surface strewn with golddust. I took up some of the snow, put it into a porcelain dish, and allowed the snow water to evaporate. A delicate yellow film settled upon the sides of the dish, very evenly distributed."

Green and red snow are to be found in a few parts of the world,

principally in the Arctic regions, the color being due to minute organisms called *Protococcus nivalis*. The most extensive deposits of red snow known, situated near Cape York, Greenland, were discovered by Captain John Ross, R. N., in 1818, from which the hills, owing to this snow, received the fanciful name of Crimson Cliffs. The color, however, as seen by the author, is a faint, dirty, dull red, and not crimson.

RAINFALL EXPERIMENTS.

In the last annual report of the Department of Agriculture, Secretary Rusk remarks as follows concerning the proposed experiments in the production of rainfall, provided for by Act of Congress:

"An amendment to the Act of appropriation for this department was adopted at the last session of Congress, placing at my disposal the sum of $2,000 for experiments in the production of rainfall, it being understood that such experiments were for the purpose of ascertaining whether such a result could be attained by the use of explosives. The difficult and problematical nature of these experiments, and the necessity of undertaking them only under the direction of a person possessing thorough qualification for conducting the work, has made it thus far impracticable for me to give the matter proper attention. The experiments will, it is expected, soon be inaugurated."

The time should be fitly chosen, and the work should be conducted under direction of meteorological experts, who are able to determine the value of the results obtained. Nothing less than this will satisfy the thousands of people, especially old veterans, who are very positive in their belief that vigorous cannonading will pound rain out from a cloudless sky. The question ought to be settled for educational reasons, though no practical benefit may result from the experiments. The Government is able to bear the trifling expense.

Some striking historic cases are cited to sustain the popular belief that heavy cannonading may produce copious rainfall under certain atmospheric conditions. At the siege of Valenciennes by the allied armies in June, 1793, the weather, which had been remarkably hot and dry, became violently rainy after the cannonading commenced. Two hundred pieces of artillery were employed in the assault, and one hundred in the defense of the city, all of which were frequently in action at the same time.

At the battle of Dresden, August 17, 1813, the weather, which for some days had been calm and intensely hot, suddenly changed, and a torrent of rain fell.

At Waterloo, according to Siborne, the weather during the morning of June 17, 1815, had been oppressively hot. It was now a dead calm; not a leaf was stirring, and the atmosphere was close to an intolerable degree, with a dark, heavy, dense cloud impending over the combatants. The Eighteenth Hussars were fully prepared and awaited the command to charge, when brigade guns on the right commenced firing for the purpose of breaking the order of the enemy's advance. The concussion seemed instantly to rebound through the still atmosphere and communi-

cate, like an electric spark, with the heavily charged mass above. A violent thunder clap burst forth, which was immediately followed by a rain which has never, probably, been exceeded, even in the tropics. In a few moments the ground became perfectly saturated.

It will be noted that in the instances above cited the conditions were favorable to heavy precipitation, and there is nothing therein to establish the correctness of the hypothesis that the concussion of atmosphere caused the downpour. Humboldt said that in South America the sudden eruption of a volcano, occurring in a dry season, sometimes changed it into a rainy one. But this may be attributed to the great heat attending volcanic discharges, which caused a sufficient disturbance of the atmosphere to produce rainfall. There is, in fact, a greater degree of probability that rainfall may be produced by an extensive conflagration than by making a great noise with big guns or dynamite bombs. But let us have the experiments with the dynamite to settle the question.

Captain James Allen, of the Signal Office, replying to interrogations recently addressed to him regarding the probability of producing rain by artificial means, said: "One fact would seem to be easily admitted, that an attempt to explode gunpowder in order to practically demonstrate the advisability of attempts in rain production, should at first be made after most careful consideration of the atmospheric conditions. For example, if the explosions should be made in the center of a high area, as shown by our weather maps, or even after a low area has passed any point, we may be absolutely certain no rain will follow. The first experiments should be undertaken to the southeast or east of a low area, and three hundred to six hundred miles from the center. Observing stations should be established every five or ten miles for two hundred miles to the eastward of the point of explosion. If the explosions are made in a comparatively clear sky, and after that unmistakable clouds are observed to the eastward and not to the westward, some connection may be surmised. It must be said, however, that even if the production of rain be practicable, it can only be for a very limited area, and it is believed that any benefit which can possibly arise from such rain can never amount to the expense of the enterprise."

THE POWERS OF THE AIR.

By Felix L. Oswald.

In the course of the last fifty years the progress of science has curiously illustrated the significance of the old saying that truth is often stranger than fiction. The good steed Bayard would be eclipsed by the iron horse as the darts of Orion are distanced by a minnie ball, and the dolphin-riding guest of King Periander would be glad to exchange his seat for the steerage berth of a Cunard steamer.

Still greater, perhaps, would be the surprise of the mystic Bodin, if he could see how far the discoveries of the nineteenth century have surpassed anything dreamed of in the philosophy of his speculations on the acts of the "Invisible Powers." Invisible disease germs are known to decide the question of life and death for countless thousands of our fel-

low men. Invisible currents of a mysterious force carry our messages with a speed immeasurably superior to that of the best broom-bestriding witch, and the "empty air" has been found to possess potencies exceeding those of all the twenty-seven varieties of aerial demons enumerated by the author of the "Enchanted World."

After a few years' cruising in the eastern Mediterranean, Sir Charles Napier became inclined to "doubt if the mariners of Greece and Rome ever experienced such a thing as a genuine tornado;" but only since the establishment of meteorological observatories have even the navigators of the West begun to realize the force exerted by a common ocean gale.

The storms of the northern Atlantic have been known to reverse the current of the tides and to upheave the waters of vast ocean areas with a force equal to a pressure of sixty billion pounds to the square mile. Storms originating on the plains of our central States have more than once reached the east shores of our continent, crossed the Atlantic, and swept over a considerable portion of Europe and western Africa, overcoming the resistance of all counter currents and displacing a bulk of atmospheric strata that could not have been more than momentarily moved by the explosion of a mountain of gunpowder.

Air currents, with their incalculable influence on the climatic conditions of our planet, have, indeed, been recognized as the most potent of all elementary agencies, and it is curious that the manifold inquiries into the proximate causes of their disturbances have as yet not led to more definite results. Dové and Redfield, the discoverers of several important atmospheric laws, suppose storms to be analogous to the eddies formed near the points of contact of two different river currents, and assume the existence of established storm-routes, corresponding to the deflections of permanent equatorial and polar waves. Storms, however, are by no means confined to the region of the permanent air currents (trade winds, etc.), and are notoriously apt to follow a protracted calm. Recognizing the local and, as it were, abrupt origin of many storms, Professor Espy tried to explain them on the following hypothesis: "Whenever the vapor of the atmosphere," he says, "is condensed into clouds or rain, the heat thus generated will rarefy the surrounding air-strata, thus causing them to rise upward, and leave a vacuum which is speedily filled by inrushing air currents from all sides. Hence, the fact that the gusts of a cyclone blow from every quarter towards the center of the storm." That theory, however, has not yet been reconciled with the circumstance that more heat is set free when vapor is condensed into snow than into rain, while snow-tornadoes are much less frequent than warm rain cyclones.

Falb's hypothesis connects the recurrence of storm periods with certain conjunctions of the planets, but tested by experience it involves as many misses as hits, and reminds the humorist Vogt of the observation recorded by an old lady who stated that the memory of many sleepless nights had taught her to expect a rain whenever she heard tom-cats howl on her roof. She owned an old rookery in the rain-clouded hills of Salzburg, and inquiries elicited the fact that her assortment of household pets included about twenty-five cats of both sexes, so that the zoölogical and meteorolgical phenomena could not help coinciding once in awhile.

Heat unquestionably plays an important part in the development of

air currents, as attested by the fact that the frequency and violence of storms increase as we approach the equator, and that in the higher latitudes thunder storms generally follow a period of more than usually warm weather. Violent gales, however, are experienced in chilly March as often as in any other two months of the year, and in the tropics the genesis of cyclones presents problems too complex for the formulation of anything like a positive rule of prediction.

But, though the cause of storms has never yet been explained in a way to reconcile all their regular and exceptional phenomena, the study of those phenomena themselves has been carried to a remarkable degree of completeness. The direction and velocity of many thousand storms have been ascertained with the aid of all sorts of self-registering instruments; the frequency of gales in respect to special seasons, months, and lunar phases, has been recorded for years, and a large number of storm-tracks have been mapped out as a surveyor would map out the course of a well defined river. These "tracks," by the way, exhibit irregularities that make it probable that the ancients must have entertained rather inadequate notions concerning the geographical extent of violent gales.

Tornadoes are strangely apt to follow a zigzag course, vertically as well as horizontally; *i. e.*, they will not only turn off suddenly in sharp angles to their former line of progress, but will seem to leave the plane of that line altogether and dart upwards into unknown heights of space, then plunge down again, and resume their work of destruction perhaps scores of miles from a point where they appeared to have exhausted their force in whirlwind and torrents of rain. Gales that seem to terminate abruptly on the table lands of central Spain may thus reappear on the coast of France, follow the coast plain north to the mouth of the Seine, turn eastward, appear to spend their fury in the gorges of the Ardennes, and like a whirlwind of local origin break out again on the plains of Holland or northern Germany.

The mode rather than the cause of these erratic deflections has been expressed in the rule that storms are apt to blow from regions of high to regions of low barometric pressure, and that they are preceded by a rise and followed by a depression of temperatures. "Gales follow the lines of least resistance;" that tendency has been summarized, but the conditions seeming to determine the direction of special air currents are apt to change too suddenly to predict the event with any degree of certainty. Experience has, however, partly compensated the lack of logical theories, and, given the direction, the temperature, and the velocity of an incipient storm, the phenomena of its development can occasionally be inferred from the analogy of recorded precedents. Thus, it has been noticed that cyclones, with all their tendency to move in curves and spirals, will not return across a given degree of latitude after their "storm centers" have once advanced to a certain distance in an opposite direction, and that north of the equator storms turn from right to left, but in the southern hemisphere from left to right, like the hands of a watch.

Theories have been elaborated to fit those facts, but we should not forget Ehrenberg's "Hint to Cosmologists," and the occasional fallacy of inductive modes of explanation. "Suppose," he says, "mountain tops should prove to be much warmer than the valleys below, would our theorists be long in formulating a science-approved explanation of the

fact? 'Warm air,' they would say, 'has a tendency to rise, as we see by the upward draught of an open fireplace and the ascending smoke-clouds of a conflagration. Those uprising currents of warm air naturally raise the temperature of lofty mountains, which, besides, are so much nearer to the sun, and catch the first and last rays of its warming light.'" *A priori* it might seem logical enough to suppose that highlands must be specially liable to the ravages of violent gales; but it so happens that destructive storms are about ten times more frequent on coast plains and on extensive table lands than anywhere in the mountains. Nor is that immunity confined to sheltered mountain valleys. Hilltops overlooking for hundreds of miles an adjoining plain have a ten-to-one chance to get off with a mere ripple of the hurricane that bursts like the crack of doom on the prairies below, and in the southern Alleghanies there are districts of several thousand square miles which, since the memory of their first settlers, have never experienced anything worse than an ugly thunder storm with its concomitants of hail and electric fire, while under the same parallels of latitude the prairies of Kansas can hardly boast a homestead that has not undergone repeated opportunities to appreciate the utility of a "cyclone pit."

The fact seems to be that storms rarely rise above a certain level, and the gales crossing our continent from west to east often appear to wreak their rage chiefly on plains bordered on the east by mountains that oppose a barrier to the further progress of the storm, which nevertheless manages to rally its forces somewhere east of the obstructive highlands. Northern Georgia forms a west-wind trap of that sort, and in 1874 the country from Edgefield to Gainesville was swept by a gale which at one point hurled a freight train from its track and discharged the load of a gravel car in a way suggesting a volley of case-shot fired from a battery of howitzers. In 1885 the same region was ravaged by a cyclone that has left its mementoes in a heavily timbered district west of the Tallulah River. About six miles east of Clarksville the storm has torn out its path in a manner strikingly illustrating the rotary movement of a tornado. Thousands of trees—tall pines, most of them, which, in the judgment of expert woodcutters, would have yielded to a one-sided push by snapping off in the middle—have been plucked out, *twisted* out, as it were, by the roots, and are scattered about in a promiscuous way as if the storm had struck them from all sorts of different directions. The helmsmen of storm-ships are often sorely bewildered by those sudden shifts of the gale, and pedestrians caught in a tornado are liable to be hurled down by a push from what a moment ago appeared to be the leeward side of the road.

The tornado that overthrew the walls of the old Roman amphitheater of Nimes, in the winter of 1827, could have lifted the "Great Eastern" from its moorings; and experts estimate that the force exerted by combined storms and breakers in the repeated destruction of the Eddystone lighthouse could have been equaled only by a protracted bombardment from a battery of heavy siege-guns. During the gale that visited the northern Atlantic in February, 1857, the west coast of Ireland was strewn with the wreck of more than one vessel that had been blown upon reefs of high cliffs; though a still more violent storm was experienced north of Birkenhead, near Liverpool, England, on the third of December, 1863, when intermittent gusts of the hurricane were, by actual measurement, proved to have attained a speed of *ninety-two* miles an hour.

Yet no local storms can give the inhabitants of the frigid latitudes more than a faint conception of the cyclones which occasionally visit the lowlands of the tropics—especially the coasts of the Caribbean Sea, of the Indian Ocean, and of the southwestern Pacific. The storm-waves dashed against the cliffs of the Philippine Islands can often be seen pouring back in torrents resembling the waterfalls of large rivers; and Varenius, in his "Geographia Naturalis," describes the typhoons of the Chinese seas as "storms which rage with such intensity and fury that those who have never seen them can form no idea of them, and which would often tempt one to say that heaven and earth wished to return to their original chaos."

The navigators of the Japan seas, too, must often feel inclined to consider the name of the "Pacific" a preposterous misnomer. The "regions of calms" specified on mariners' charts represent merely the interspaces of the trade-wind tracks, and are by no means specially exempt from the visitation of destructive storms. Of all seas thus far discovered, that advantage can be claimed most fairly for certain sheltered bays of the eastern Mediterranean; of all *terra firma* regions, for the upper valley of the Sacramento River, in Northern California.

METEOROLOGICAL CONDITIONS OF ARID REGIONS.

[Monthly Weather Review.]

At the recent annual meeting of the Scottish Meteorological Society, Dr. John Murray read an interesting paper on the meteorological conditions of desert regions, with special reference to the Sahara, the northern border of which he had recently visited.

He pointed out that the arid regions of the world are distributed in two bands, north and south of the equator. They are all inland drainage areas, or areas where the streams have no connection with the sea. They are also regions where evaporation is in excess of precipitation, for if the latter were in excess the water would rise until it could flow into the sea, as in the case of the great lake district of North America, and the area would no longer be one of inland drainage. The largest of the deserts, the Sahara, is about three and a half million square miles in area, and the area of all the deserts of the world together is about eleven million five hundred thousand square miles. That is to say, over one fifth of the land of the world has no outlet for drainage to the sea, and in all that area evaporation is greater than precipitation. These areas correspond very closely with the regions of the world where the rainfall is less than ten inches annually. In no place in the world can there be found such enormous changes of temperature as in the deserts. In the Sahara, the temperature sometimes falls from 100 degrees during the day to the freezing point during the night. This arises from the great dryness of the atmosphere, and from the radiation that takes place from the burning soil after the sun has set. These inland drainage areas correspond very much in their barometric phenomena. In all desert regions during the summer all winds blow into

them. In winter the reverse takes place, the winds flow out of them, and that holds good both for the northern and southern hemispheres. This leads to the low rainfall, for the great majority of these regions are more or less bounded by high hills. The winds come into the deserts over these hills, and the vapor is precipitated from the atmosphere by the hills, with the result that when the winds reach the interior regions there is nothing left to be deposited. If there are not hills all around any desert area, then, as in the case of northern Asia, the winds pass from a colder to a warmer climate, and as they get to warmer regions they are able to contain more vapor, and none is precipitated.

Dr. Murray examined the Sahara region geologically, and found that the formation of rocks was entirely that of fresh water, and of Quaternary date. The great majority of geographers and geologists have expressed the belief that the whole of the Sahara is an old seabed, but in his opinion it has never as a whole been covered by the sea since Cretaceous or Devonian times, and no part of it has been covered by the ocean since Tertiary times. The whole question about the discovery of shells seems to rest upon one common species being found very rarely in one region of the desert. Owing to recent researches, the opinion as to the Sahara being an old sea bottom is very likely to disappear from our text-books. He considers that the features of the region have been produced by atmospheric conditions. The sand is the product of the disintegration of the rocks *in situ*. The existing rock is not far below the surface, and by digging down to it the hard sandy particles are found imbedded in the stone. The sun shone on the rocks and they expanded. The sudden cooling at night broke them up, the wind carried away the smaller particles, and so continually the rocks are being disintegrated by means of changes other than water, although water in times past played a greater role there than it does now. There is a range of hills in the desert seven thousand feet high, and for three months in the year their summits are covered with snow. Descending the hills are old river courses, some of great length. Much of the region he considers has once been a large fresh water lake. Speaking of the commercial aspect of the Sahara, he said it was difficult to go there without becoming enthusiastic about it. There seems to be no limit to the amount of water that can be obtained by sinking artesian wells.

ANOTHER WORLD.

By Camille Flammarion.

The astronomers have again made an unexpected, a marvelous, and altogether a most original discovery.

They have just found out a world which has neither hours, days, nights, weeks, months, years, nor centuries—a world without an almanac.

This world is not far off, astronomically speaking. A telegram or a telephone message would reach it in five minutes. It belongs to the same celestial circuit as ourselves. It is one of the globes of our solar system. It is Mercury.

Yes, Mercury, that beautiful star bathed in the lucent fires of the solar rays, who was identified with Hermes by the graceful and ancient mythology of the Greeks, and personified by having wings attached to his feet, making him the nimble-footed messenger of Olympus, the faithful companion of Apollo, and at a late day the god of doctors, apothecaries, thieves, traffic, and gain; Mercury, whom we but seldom catch sight of in our latitudes, because he always strays too near the sun and swims into our vision only as a morning or an evening star less brilliant and more fugitive than Venus; a planet, in fact, that astronomers have been watching for thousands of years, and that our first parents in the Garden of Eden were, no doubt, able to contemplate in the half dream which precedes the hour of rest and that of awakening. Yes, Mercury has recently been the object of new and scrupulous investigations, and from what has been made out it would seem that he merely circles round the sun in such a way that he constantly presents to that luminary the same unvarying hemisphere. This is certainly something novel and altogether unexpected.

Astronomers have hitherto thought that Mercury rotated like our earth in twenty-four hours, and for the following reasons:

The geographical outlines on the surface of Mercury are very difficult to observe. They are weak, pale, and illy defined. As, moreover, this planet turns round the sun in an orbit included within that of the earth, a moment of reflection will show that Mercury is nearest to us when he passes between the sun and the earth. But at that time he turns his dark side toward us, so that the conditions are obnoxiously adverse to telescopic research. At better hours when, half an hour or an hour after sunset or before sunrise, he is in quadrature and can be seen with the naked eye, he appears through the instrument in the shape of a small half-moon. This phase, as he approaches our earth, is gradually changed to that of a very slender crescent. To see Mercury with rounded form and fully illuminated orb we must choose the periods when he passes beyond the sun. He is then at a great distance from us, very small in size, and eclipsed by the dazzling blaze of the solar light.

It will thus be seen that the chances for a proper physical observation of this planet are extremely meager. Nevertheless, towards the close of the last century, several astronomers, and among these more especially Schroeter, devoted their attention to the task. The result of their investigations showed that Mercury underwent little change in appearance from one night to another, and that the spots seen to-day, for instance, would be seen again to-morrow at the same hour of observation. And the inference was drawn that this globe rotates like the earth in about twenty-four hours.

Of this, however, we are not quite sure, because the spots on Mercury's surface were never seen to move from one edge across to the other edge, as in the case with Mars or Jupiter. In observing the latter, three hours are sufficient to establish beyond doubt that they rotate on their own axes. But Mercury does not remain long enough above the horizon to let the eye follow his career for several hours.

Matters had thus stood for about a hundred years, when one of the most laborious and skillful of living astronomers, M. Schiaparelli, Director of the observatory at Milan, to whom science is already indebted for the discovery of the enigmatic canals on the planet Mars,

and the still more enigmatic duplication of those canals, resolved to apply that excellent instrument which had wrought such wonders in the case of the planet Mars to the minute study of Mercury, and he at once went to work.

As Mercury sets almost immediately after sunset, or rises but shortly before sunrise, the great Italian astronomer soon found that he had nothing to expect from a single hour of observation each day, and that some other mode must be adopted to overcome the difficulty. This was the more evident, as in order to be able to explore the full disk he had, perforce, to select those epochs when the planet approaches the time of its greatest elongations. The only means left was to observe Mercury, not in the morning or the evening, but by day, in the full blaze of the sun, and when the planet was in close propinquity to the dazzling orb.

That is what the Milan astronomer has done, and success has crowned his endeavors.

For seven years (he commenced his observations of Mercury in 1882) he has turned to profitable account those best days, when sun and atmosphere were most calm and pure, directing his equatorial toward the planet when nearest to the solar orb, and making drawings of what his eagle eye could discover on its surface.

He has thus been able to obtain several hundred sketches.

On all of these drawings, each of which confirms the other, may be seen long gray streaks, that possibly represent seas or forests. The streaks do not move over the planet's disk as clouds might do, but remain immovable, fixed as the soil of Mercury itself. Several of the streaks assume rather singular shapes. For instance, there is in the west an arrangement which figures to all appearance a huge 5.

These streaks do not move away; at whatever hour of the day or period of the year they are sought they are to be found. Whether the planet is to the right or left beyond the sun, and whether affording to our eye a full disk, a half-moon, or a crescent, these streaks are always to be noted at the same spot on Mercury's globe.

And again, no other streaks are ever to be seen unless they happen to be some white passing clouds.

They are permanent. Mercury revolves round the sun in eighty-eight days, constantly presenting to that luminary the same hemisphere streaked with the geological outlines in question. Thus Mercury circles round the sun just as the moon does round the earth, with the same side always turned toward the central orb of our system.

But with this result: that the conditions of life and the measurement of time are very different as regards Mercury from those connected with our satellite. While the regular movement of rotation of the latter gives to the moon days and nights fifteen times longer than our own, the circling motion of Mercury affords perpetual daylight to that side of his sphere which is turned toward the sun and perpetual darkness to the other side.

Such a state of things must certainly entail the strangest conditions of existence.

It is much the same as if the sun, for instance, never sank below the horizon for us, and never rose above it for our antipodes. The sun everlastingly hovers at the zenith of the central point in the diurnal hemisphere; it does not, however, remain absolutely motionless. As Mercury revolves round the orb of day while describing, not the circumference of

a circle, but an elongated ellipse, an irregularity in its movements results by which the sun seems to slowly poise—or appear stationary—in the heavens of the Mercurians on either side the zenith of the central meridian to which I have just alluded. Thus he glides on the east as well as on the west as far out as 23° 41′ on either side—his oriental excursion taking up fifty-one days and his occidental one thirty-seven, or eighty-eight days in all, which is the time of Mercury's orbit round the sun.

This alternate movement has for effect to give sunlight to the dark side of Mercury's sphere to an extent, however, not exceeding an angle of 23° 41′ from the mean line separating the two hemispheres. But all the central regions of the side opposite that facing the sun are condemned to perpetual darkness.

It is endless day on one side and endless night on the other. Dante has described the former in his ineffable circles of Paradise and the latter in the asphaltic lake of outer darkness in the Inferno.

On the one side is light, and always light; on the other, never-ending gloom. The diurnal hemisphere has the sun constantly on the equator. Fancy yourself in Columbia, Guiana, the Congo, to the south of Senegal, in Zanzibar, Sumatra, at Borneo, New Guinea, or in the islands of the Malaysian Sea, with the sun at its zenith, vertically darting down its rays upon your head. And what a sun! Mercury is, on an average, only thirty-six millions of miles from the sun, while we are about ninety-five millions of miles. The great orb of day appears seven times larger as viewed from his surface than as seen by us, and sends, on an average, seven times more light and heat. I say on an average because, as we have seen, the planet follows in his course an elongated ellipse so that every forty-four days it attains a maximum and a minimum of distance. In the first case the solar disk appears only four and a half times larger than with us; but in the other position it grows to be ten and a half times larger in size. What a focus of light and heat! We sometimes complain of the heat of our distant sun; but what is our luminary when compared with the dazzling brazier of Mercury? It is as if ten suns converged over our heads at the summer solstice, whose united rays poured down at noon their concentrated heat upon us; and this not for a season only, but ever and ever. Mercury's seas must be oceans of boiling water.

A perpetual day! There is neither evening nor morning. There is no night.

There are no stars, and consequently there is no astronomy, no apparent movement of the heavens. There are no hours.

Mercury has no satellite. It follows there are no months, no weeks, no measure of time that way.

Neither are there any years. When would they begin or end? Here on our earth the year is made up of a certain number of days and nights. But how conceive a year where the day is without end?

Doubtless the sun periodically seems to increase and diminish in size, and the temperature also varies considerably. These would constitute seasons of a new order. Have Mercury's inhabitants guessed that they circle round the sun; and that the variation in the distance of that orb accounts for the difference in the size of the brazier suspended over their heads? These strange seasons seem to be the only measure of time Nature has given them.

No night! And doubtless no sleep. Do they live better and longer? Do they grow old? They seem to be without days, years, or any age. Perhaps it is the land where people never die.

The atmosphere they breathe would seem to be more extended than our own, and to be at times here and there overcast with condensations that look like clouds.

From such an arrangement the seasons would be distributed regularly, a maximum of heat prevailing in those central regions of the hemisphere facing the sun, and a maximum of cold existing in the central regions of the dark hemisphere. On the latter side extends the starry night suitable to astronomical studies, the observation of our earth that sparkles in their sky like a bright star, and besides which may be seen, even with the unassisted eye, to revolve the moon. It is not at all unlikely that the inhabitants have been led to organize trips to go from one hemisphere to the other when some in turn visit the regions bathed in a sunshine they had never beheld, and others an unknown night and the marvels of a starry sky.

Seneca wrote two thousand years ago that if humanity had not been accustomed from the womb to those daily wonders it would know better how to appreciate them; and that if there was a country in the world where the starry sky would be revealed in its magnificence, reflective people would have undertaken voyages for the purpose of describing such infinite splendors. The world which the astronomers have just revealed is possibly the world Seneca had in his mind when he wrote. Let us hope that it contains no Neros, and that the Senecas in it do not meet death by having their four veins opened in a bath.

THE CURIOUS HISTORY OF A LADYBIRD—HOW IT SAVED THE ORANGE INTERESTS OF CALIFORNIA.

[Scientific American Supplement, April 4, 1891.]

Various accounts have been published during the past year of the extraordinary success of the importation of Australian natural enemies of the fluted scale, otherwise known as the "white scale" and as the "cottony cushion scale" (*Icerya purchasi*), into California, and particularly concerning the ladybird (*Vedalia cardinalis*), which has done such excellent and satisfactory work in destroying the injurious scale. No connected account has, however, been published. The results are of such paramount interest as indicating the value of the study of all details connected with the life history of the injurious pests, that we compile a brief history of the interesting experiment.

Persons who have visited California of late years are familiar with the enormous amount of damage done by the scale insect in question, which, indeed, up to the year 1889, threatened the entire subversion of the orange and lemon interests in California. The insect was considered at length in the annual report of Prof. C. V. Riley, an entomologist to the Department of Agriculture, for 1886. Long accounts of experiments with various washes by agents of the department were given, and

importation of parasites was considered. Professor Riley made use of the following expression:

> Considering the fearful losses already occasioned to California orange growers by two species (the Icerya in question and the California red scale) introduced from Australia, we know of no way in which the department could more advantageously spend a thousand dollars than by sending an expert to Australia to study the parasites of the species there and secure the safe transport of the same to the Pacific Coast.

In the spring of 1887 he urged a similar course in an address before the State Board of Horticulture, at its meeting at Riverside, having, by careful personal study and correspondence, ascertained that the insect was, without doubt, an importation from Australia, and that it had natural enemies there which kept it in check. In the winter of 1887–88 an appeal was made to Congress, by those interested, for an appropriation to send one or two men to Australia to collect and introduce these natural enemies of the scale. Congress, however, not only failed to make a specific appropriation, but failed, likewise, to remove the restricting clause in the appropriation to the Department of Agriculture which limited traveling expenses to the United States.

Imbued with a sense of the importance of the attempt, and unbaffled by the non-action of Congress, Professor Riley conceived the idea of taking advantage of the Melbourne Exposition. By an arrangement made with the Department of State the Commissioner of Agriculture was finally able to send to Australia two agents of the Entomological Division under instructions from Professor Riley, their expenses not to exceed $2,000, to be paid out of the Melbourne appropriation.

This coöperation of the two departments was entered into in the belief that it would be mutually beneficial, it being arranged that one of the agents should work under instructions with the Commissioner General, and assist in reporting on the agricultural aspects of the exposition, while the other was commissioned under instructions of the entomologist, and to devote himself solely to the study and importation of the natural enemies of the fluted scale, and report to Professor Riley. It was the latter's original intention to proceed to Australia himself, but finding that his divisional duties and those which he had assumed in connection with the Paris Exposition precluded his so doing, Mr. Albert Koebele was commissioned at his request to proceed to Australia and carry out the entomological work there. The history of Mr. Koebele's efforts has been from time to time detailed in "Insect Life," a periodical bulletin of the Entomological Division, and particularly in Bulletin No. 21, which contains the official report of Mr. Koebele's trip. A large number of living enemies of the fluted scale, both parasites and predaceous species, were imported into California and turned over to another agent of the division, Mr. D. W. Coquillett, at Los Angeles, Cal. One of them, however, the Vedalia, proved so effective as to throw the others entirely in the shade and render their services unnecessary. A recent department publication remarks:

> The little ladybird, which has thus proved itself such a useful aid to California orange growers, has so far received no popular name, but it is already extensively known and spoken of in California as the "Vedalia," a name which will come to be as common in our language as many other names that were originally purely technical, like phylloxera, geranium, etc. It is a small, reddish species, and has four black spots on the back, and confines itself almost exclusively to the fluted scale. It has, so far, not been noticed to prey upon any other insect, a fact which accounts somewhat for its exceptionally rapid work, and renders the outlook extremely encouraging.

It breeds with surprising rapidity, and occupies less than thirty days from the laying of the eggs until the adults again appear. At this rate of increase, calculating that three hundred eggs are laid by each female, and that half of these produce females, it will readily be seen that in six months the offspring of a single female beetle may, under favorable circumstances, amount to over seventy-five billions.

A report published a year ago from Prof. W. A. Henry, Director of the Wisconsin Experiment Station, who was commissioned by the department to report on the work of its agents on the Pacific Coast, contains the following expression:

A word in relation to the grand work of the department in the introduction of this one predaceous insect. Without doubt it is the best stroke ever made by the Agricultural Department at Washington. Doubtless other efforts have been productive of greater good, but they were of such character that the people could not clearly see and appreciate the benefits, so that the department did not receive the credit it deserved. Here is the finest illustration possible of the value of the department to give people aid in time of distress. And the distress was very great indeed; of all scale pests, the white scale seems most difficult to cope with, and had no remedy been found it would probably have destroyed the citrus industry of the State, for its spreading to every grove would probably be only a matter of time. It was the Department of Agriculture at Washington which introduced the Washington Navel orange into South California, and the department has now given an effective remedy for the worst scale insect. The people will not soon forget these beneficial acts.

Wm. F. Channing, of Pasadena, Cal., son of the eminent Unitarian divine, in a recent letter to a friend, who has permitted us to publish it, gives the following experience:

We owe to the Agricultural Department the rescue of our orange culture by the importation of the Australian ladybug, *Vedalia cardinalis.*

The white scale were incrusting our orange trees with a hideous leprosy. They spread with wonderful rapidity, and would have made citrus growth on the whole North American continent impossible within a few years. It took the Vedalia, where introduced, only a few weeks absolutely to clean out the white scale. The deliverance was more like a miracle than anything I have ever seen. In the spring of 1889 I had abandoned my young Washington Navel orange trees as irrecoverable. Those same trees bore from two to three boxes of oranges apiece at the end of the season (or winter and spring of 1890). The consequence of the deliverance is that many hundreds of thousands of orange trees (Navels almost exclusively) have been set out in Southern California this last spring.

In the Agricultural Report for 1889, which has just been published, Professor Riley thus speaks of the ultimate issue between the ladybird and its prey:

We may hardly hope, however, that the last chapter in the story is written. On the contrary, it is more than probable, and in fact we strongly anticipate, that the Icerya will partially recuperate; that the Vedalia will, after its first victorious spread, gradually decrease for lack of food, and that the remnants of the fluted scale will, in the interim, multiply and spread again. This contest between the plant feeder and its deadliest enemy will go on with alternate fluctuations in the supremacy of either, varying from year to year according to locality or conditions; but there is no reason to doubt that the Vedalia will continue substantially victorious, and that the power for serious harm, such as the Icerya has done in the past, has been forever destroyed. We have learned, also, that it will always be easy to secure new colonizations of the Vedalia where such may prove necessary, or even new importations should these become desirable.

In other words, the victory over this scale is complete and will practically remain so, and we agree with our entomologist when he says in the same report that "the history of the introduction of this pest; its spread for upward of twenty years, and the discouragement which resulted; the numerous experiments which were made to overcome the insect, and its final reduction to unimportant numbers by means of an apparently insignificant little beetle, imported for the purpose from Australia, will always remain one of the most interesting stories in the records of practical entomology."

MONSOONS OF NORTH AMERICA.

By Lieut. J. P. Finley, U. S. Signal Service.

On the continent of North America we have monsoon influences similar to those of Asia, but not nearly so strong, because the extent of the continent, and consequently the annual range of temperature, are not so great. They are, for the most part, not sufficiently strong to completely overcome and reverse the current of the general circulation of the atmosphere, and so to produce a real monsoon, but they cause great differences between the prevailing directions of the winter and summer winds. In the summer the whole interior of the continent becomes heated up to a temperature much above that of the oceans on the same latitudes on each side; indeed, above that of the Gulf of Mexico and the Pacific Ocean on its southern and southwestern borders. The consequence is that the air over the interior of the continent becomes more rare than over the oceans, rises up and flows out in all directions above, while the barometric pressure is diminished, and the air from all sides, from the Atlantic on the east to the Pacific Ocean on the west, the Gulf of Mexico on the south, and the Polar Sea on the north, flows in below to supply its place.

On the east the tendency to flow in is not strong enough to counteract the general easterly motion of the air at the earth's surface in the middle latitudes, and to cause a westerly current, but it simply retards the general easterly current, and gives rise to a greater prevalence of easterly winds along the Atlantic seacoast during the summer season.

On the southern and southeastern coasts the heating up of the interior causes the prevailing winds to be southerly and southeasterly instead of northeasterly, as they otherwise would be in these trade-wind latitudes. The monsoon influence in the Mississippi Valley and westward is much strengthened by the gradual slope from this valley up to the high plateaus east of the Rocky Mountain range, so that when this slope becomes heated in summer the surface air tends to flow up it toward the mountain range, and causes winds which otherwise would be southerly ones to become more southeasterly, and the southwesterly winds to become southerly ones.

In winter the thermal conditions over the continent are reversed. The interior of the continent is now the coldest part, and it is especially colder than the surrounding oceans at that season. It has also very high plateaus and mountain ranges.

The air, therefore, of the lower strata, and especially those next to the earth's surface, now tends to flow out in all directions to the warmer oceans and the Gulf of Mexico, and especially to run down the long slope of plateau from the Rocky Mountains into the Mississippi Valley. The effect over the whole of the United States east of the Rockies is to cause the winds, which otherwise would be westerly and southwesterly, to become generally northwesterly winds instead of southerly and southwesterly ones, as in summer. There is not a complete monsoon effect, but simply a great change between summer and winter in the prevailing directions of the winds. In Texas, however, and farther east along the northern border of the gulf, the effect is somewhat that of a complete

monsoon. In New England, and farther south in the Eastern States, the monsoon effect is to cause the prevailing winds to be from some point north of west, instead of south of west, as in summer. Along the west coast of North America, in the middle latitudes, there is a strong monsoon influence, for the interior of the continent becomes heated in summer to a much higher temperature than that of the southwesterly ocean, and hence a strong current is drawn in from this direction at right angles to the general trend of the coast, which, combining with the general southwesterly winds of these latitudes in the general circulation of the atmosphere, causes the strong and steady westerly and southwesterly winds of this region during the summer.

Farther north, toward Alaska, the summer monsoon effect is combined with the current caused by the deflection of the continent as well as the general easterly current of high latitudes, so that the winds here are generally southerly, but still have somewhat of a monsoon character. All along the northern coast of America, as along that of Siberia, the monsoon tendency is to draw the air from the colder land to the warmer ocean in winter, and the reverse in summer. These effects, combined with the general easterly motion of the atmosphere in these latitudes, gives rise to prevailing southwesterly winds in winter and northwesterly winds in summer. The winter monsoon influence is small—much more so than in Siberia, for the ocean contains so many large islands that it has rather a continental than an oceanic winter temperature. Besides, it has not the influence of a warm current, such as the continuation of a part of the Gulf Stream along the northern coast of Europe, and the Japan current on the eastern coast of Asia.

THE VITICULTURAL INDUSTRY.

The following tables of the viticultural products of the United States for 1890 are taken from the latest bulletin issued from the Census Bureau, under date of March 10, 1891.

The first table gives the total area and production of vineyards and capital invested for each county in the State of California in the viticultural belts of the State, while the second table gives the same data in the United States, by States. The data is new, and also extremely valuable and interesting.

For the purposes of the investigation, the products of viticulture were classed under three distinct heads, namely, grapes for table use, grapes for raisins, and grapes for wine.

The data was prepared by H. Gardner, of the United States Census Bureau, under charge of Robert L. Porter, Superintendent of Census:

AREA AND PRODUCTION OF VINEYARDS, AND CAPITAL INVESTED, IN THE PACIFIC DIVISION OF THE UNITED STATES.

Pacific Division.	Area in Bearing Vines—Acres.	Area in Non-bearing Vines—Acres.	Average Yield of Grapes per Acre—Tons.	Market Value of Grapes er Ton.	Grapes Sold for Table Use—Tons.	Grapes Sold to Wineries—Tons.	Wine Made—Gallons.	Market Value of Wine per Gallon.	Raisins Produced (20 pounds to box)—Boxes.	Market Value of Raisins per Box.	Total Value of Plant, Including Land.	Total Laborers Employed (all kinds).
Arizona	1,000	1,500	3.00	$16 50	2,850	150	25,000	$1 00			$75,000	1,250
California:												
Alameda County	6,500	1,625	1.50	17 66	600	9,150	1,000,000	19			4,062,500	4,000
Amador County	1,000	250	1.50	17 66	100	1,400	80,000	19			500,000	640
Butte County	800	100	1.94	17 66	1,000	200	32,000	19	11,800	$1 60	360,000	450
Calaveras County	1,440	360	1.51	17 66	400	1,760	115,200	19	800	1 60	720,000	900
Colusa County	506	126	2.13	17 66	1,060	42	40,500	19			221,200	300
Contra Costa County	4,000	1,000	1.50	17 66	700	5,300	320,000	19			2,000,000	2,500
El Dorado County	1,600	400	1.50	17 66	600	1,800	128,000	19			700,000	1,000
Fresno County	16,000	3,750	1.75	17 66	360	9,000	1,200,000	19	626,595	1 60	7,900,000	9,900
Inyo County	95	24	1.44	17 66	30	107	7,600	19			41,650	60
Kern County	750	187	1.50	17 66	150	975	60,000	19			237,950	470
Lake County	1,185	246	1.50	17 66	900	877	78,800	19			500,850	700
Los Angeles County	18,120	4,530	1.51	17 66	1,000	25,820	1,342,800	19	20,000	1 60	11,325,000	11,500
Marin County	520	130	1.50	17 66	100	680	41,600	19			227,500	300
Mariposa County	500	125	1.50	17 66	100	650	40,000	19			218,750	300
Mendocino County	208	27	1.50	17 66		312	8,700	19			82,250	150
Merced County	2,014	128	2.36	17 66	400	2,621	41,200	19	58,400	1 60	856,800	1,100
Monterey County	500	50	2.00	17 66	1,000		16,000	19			191,500	300
Napa County	16,611	4,152	1.50	17 66	530	24,386	3,000,000	19			10,381,500	10,300
Nevada County	235	59	1.50	17 66	40	312	18,800	19			102,900	150
Placer County	2,621	555	1.72	17 66	3,620	311	177,700	19	19,400	1 60	1,270,000	1,600
Sacramento County	6,465	1,616	1.54	17 66	3,050	6,647	872,850	19	9,000	1 60	3,232,400	4,050
San Benito County	110	27	1.50	17 66	35	130	8,800	19			47,950	70
San Bernardino County	9,562	4,125	1.98	17 66	1,700	6,000	279,000	19	375,000	1 60	4,790,450	6,850
San Diego County	6,000	7,500	1.50	17 66	1,220	3,280	30,000	19	150,000	1 60	4,725,000	6,750
San Joaquin County	2,000	500	1.75	17 66	1,840	1,160	160,000	19	17,200	1 60	1,000,000	1,250
San Luis Obispo County	652	138	1.59	17 66	1,000	38	5,000	19			276,500	400
San Mateo County	750	187	1.63	17 66	160	1,065	60,000	19			327,950	470
Santa Barbara County	1,125	281	1.82	17 66	2,000	56	7,500	19			492,100	700
Santa Clara County	10,000	2,500	1.50	17 66	1,500	13,500	2,260,000	19			6,250,000	6,250
Santa Cruz County	1,500	375	1.50	17 66	640	1,610	284,000	19			656,250	950
Shasta County	500	125	1.84	17 66	200	550	25,000	19	5,800	1 60	218,750	300
Sierra County	250	62	1.50	17 66		375	12,500	19			105,000	150

Siskiyou County	4	1	....	17 66	....	....	200	19	....	....	800	2
Solano County	3,500	875	1.50	17 66	700	4,550	280,000	19	....	....	1,750,000	2,200
Sonoma County	21,683	5,421	1.50	17 66	2,150	30,374	1,756,300	19	....	....	13,552,000	13,550
Stanislaus County	498	124	1.50	17 66	....	747	39,900	19	....	....	217,700	300
Sutter County	430	207	2.90	17 66	190	455	35,400	19	20,200	1 60	222,950	350
Tehama County	4,972	1,243	1.50	17 66	850	6,608	397,800	19	....	....	2,486,000	3,100
Trinity County	220	5	1.82	17 66	400	2	250	19	....	....	78,750	110
Tulare County	4,500	875	2.00	17 66	6,700	2,000	15,000	19	10,000	1 60	1,881,250	2,700
Tuolumne County	890	222	1.50	17 66	....	1,335	71,200	19	....	....	288,200	550
Ventura County	800	200	1.50	17 66	160	1,040	8,000	19	....	....	350,000	500
Yolo County	3,491	798	1.91	17 66	1,600	3,636	255,200	19	48,000	1 60	1,720,000	2,150
Yuba County	165	41	1.50	17 66	....	247	13,200	19	....	....	70,000	100
New Mexico	1,186	9,000	3.00	45 00	1,779	1,779	296,500	86	....	....	3,055,800	5,093
Totals	157,458	55,772	....	....	43,414	*173,037	14,947,500	....	1,372,195	....	$89,771,150	106,765

*This table does not include for California 41,166 tons made into raisins, and 23,252 tons used for dried grapes and purposes other than table fruit.

TOTAL AREA AND PRODUCTION OF VINEYARDS, AND CAPITAL INVESTED, IN THE UNITED STATES, BY STATES.

STATES.	Area in Bearing Vines—Acres.	Area in Non-Bearing Vines—Acres.	Average Yield of Grapes per Acre—Tons.	Market Value of Grapes per Ton.	Grapes Sold for Table Use—Tons	Grapes Sold to Wineries—Tons	Wine Made—Gallons.	Market Value of Wine per Gallon*	Total Value of Plant, Including Land.	Total Laborers Emloyed—All Kinds.
Arizona	1,000	1,500	3.00	$16 50	2,850	150	25,000	$1 00	$75,000	1,250
California	155,272	45,272	‡1.77	17 66	38,785	§235,526	14,626,000	19	86,640,350	100,422
Georgia	1,938	2,154	1.33	96 00	1,938	646	107,666	1 15	1,227,600	2,046
Illinois	3,750	990	2.00	54 00	6,000	1,500	250,000	1 00	1,422,000	2,370
Indiana	3,850	1,000	1.75	67 00	5,390	1,347	224,500	1 00	1,455,000	2,425
Kansas	4,542	1,000	2.00	58 00	8,294	790	130,990	80	1,662,600	2,771
Missouri	10,000	1,764	3.00	50 00	22,500	7,500	1,250,000	56	4,605,600	5,882
New Mexico	1,186	9,000	3.00	45 00	1,779	1,779	296,500	86	3,055,800	5,093
New York ‖	43,350	7,650	1.75	70 00	60,687	15,172	2,528,250	50	20,400,000	25,500
North Carolina	4,000	1,200	1.75	60 00	4,667	2,333	388,833	1 00	1,560,000	2,600
Ohio	28,087	4,956	1.80	57 00	38,947	11,609	1,934,833	56	13,217,200	16,521
Tennessee	1,500	600	2.50	89 00	2,500	1,250	208,333	1 00	630,000	1,050
Virginia	4,100	1,600	2.00	60 00	5,434	2,766	461,000	1 00	1,710,000	2,850
Other States and Territories	45,000	15,000	2.00	60 00	67,500	22,500	1,875,000	1 00	18,000,000	30,000
Totals	307,575	93,686	----------	----------	267,271	384,868	24,306,905	--------	$155,661,150	†200,780

NOTE.—There were 1,372,195 twenty-pound boxes of raisins produced in the United States, of which the entire lot came from California. The market value is $1 60 per box.

*The price of wine, as given for the various divisions and States in the tables of this bulletin, is that of the producer, being the home or farm value, and not the export or commercial price, after it may have passed through several hands.

†It should be noted that while the average number of laborers employed in viticulture is shown to be one person to two acres, the average for those directly employed in growing the grapes is but one person to three acres, the others being engaged in the curing of raisins, manufacture of wine, transportation of products, etc.

‡The average yield of grapes per acre for California was, in the year 1889 (the census crop), considerably reduced by the heavy rains in October, coming a month sooner than usual, and destroying a large percentage of the crop. The usual yield of grapes per acre in California is from one and a half to ten tons, the latter figure being for raisin grapes, of which two and sometimes three crops are harvested from the same vines in one season.

§This includes for California 41,166 tons made into raisins, and 23,252 tons used for dried grapes and purposes other than table fruit.

‖Includes 1,000 acres in Erie County, Pennsylvania, known as part of the Chautauqua District of New York.

CALIFORNIA.

There are fifty-three counties in California, nearly all producing grapes in a greater or less degree, the larger proportion of them producing wine for home consumption or export. There is an established demand for this wine to the amount of 1,000,000 gallons per month from this country alone, making 12,000,000 gallons annually, and an exportation to foreign countries of 311,920 gallons in 1889, valued at $217,093.

California may be divided into three grape-growing districts: The coast, which includes Sonoma, Lake, Napa, Alameda, Santa Clara, and Santa Cruz Counties; the Sierra Nevada foothill and Sacramento Valley district, which includes Placer, El Dorado, Calaveras, Tuolumne, Yuba, Yolo, Butte, Sacramento, and Tehama Counties; and the southern district, which includes San Joaquin, Merced, Fresno, Tulare, Kern, Ventura, Santa Barbara, San Bernardino, Los Angeles, and San Diego Counties.

In the first district the finer grades of white and red dry wines are made. The choice varieties of the French and German types seem to come nearer to reproducing themselves here than elsewhere. In this district are successfully grown the finest varieties of French champagne grapes, which yield a handsome profit to the producers. There is one cellar in this district with a capacity of 800,000 bottles, producing champagne by natural fermentation in the bottle. The champagne industry in California is a growing one, and its future is bright with promise. While wine is the leading viticultural product, fine table grapes are also produced in this district.

Some good, wholesome dry wines are produced in the second district, but they are of a different character from the German and French types. Grapes for table use and raisins are extensively grown, a large portion of the new plantings being for raisins.

In the Sacramento and San Joaquin Valleys, and in the southern district, some excellent dry wines are produced, but these valleys excel in their Port, Muscatel, Angelica, and other heavy sweet wines.

For the purposes of this bulletin it is only necessary to treat of the principal counties in each district where the heaviest viticultural products are found.

First District.

In Napa County there are 20,763 acres. Phylloxera has destroyed many acres of vines in this county, but the acreage has been kept up to about the same point by replanting on resistant stock and the planting of new vineyards farther up on the foothills, where a choice variety of grapes is grown and phylloxera is not such a scourge. There are 142 wine cellars in Napa, many of them of modern construction, containing all the appliances for the manufacture and handling of wines. There were 3,000,000 gallons of wine made in this county in the year 1889.

Sonoma County, in 1889, had 21,683 acres of bearing vineyards. The same conditions exist here relative to the quality of grapes and wines produced as in Napa. The ravages of phylloxera were felt in Sonoma at an earlier day than in Napa, appearing about 1874, and a great many vineyards were destroyed. It is now generally believed that the destruction caused by the phylloxera can be stayed by growing the native resistant stock and grafting upon that the foreign vinifera. In

Sonoma County, in 1889, there were produced about 1,756,300 gallons of wine and 250,000 gallons of brandy. The quality of the dry white wines was marked.

Santa Clara County contains some 10,000 acres of bearing vineyards, and should enjoy a reputation for fine white and red wines equal to Sonoma and Napa. This and Santa Cruz County, in 1889, produced 2,544,000 gallons of wine. As yet the phylloxera has troubled the vineyards but little in comparison with the counties before mentioned. There is said to be a deep gravelly bed underlying this whole surface, in which the growers say the phylloxera does not work with success. Alameda County has 6,500 acres of bearing vines, and produces a type of wine resembling the white and red wines of France, and in that part of the district known as the "Livermore District," a high grade of Sauterne and claret is produced. The geological formation of the valleys and slopes of the Mount Diablo range more nearly reproduce the soil conditions that characterize the Department of the Gironde in France than any other section on the coast. In this district there were produced in 1889 some 60,000 gallons of wine, noted more for the quality than for the quantity which it produces. This is comparatively a new wine district, and has grown up within the last decade. The first systematic planting of high grade grapes began in 1882.

Second District.

There is in the second district a great viticultural interest, embracing table grapes, raisins, sweet and dry wines, and brandies, excelling in the latter. Sacramento, Placer, El Dorado, Tehama, Yuba, Butte, and Yolo Counties produce large quantities of table grapes, and quite a quantity of raisins is shipped from these counties. Tehama has the largest vineyard in the world, 3,800 acres, to which the manager says 1,000 acres of new vines are to be added within a year. There were in the distillery on this vineyard in April, 1890, when visited by the special agent of the Census Office, 300,000 gallons of brandy and 1,000,000 gallons of wine. Another large vineyard, the second largest in the State, contains 2,100 acres, and is situated at Natoma, Sacramento County. The winery belonging to the vineyard has a capacity of 600,000 gallons. Many table grapes are shipped from this vineyard to the eastern markets. The sales in this direction have largely increased during the past two seasons.

Third District.

The third district is composed of San Joaquin, Merced, Fresno, Tulare, Kern, Ventura, Santa Barbara, Los Angeles, San Bernardino, Orange, and San Diego Counties. Near Stockton, in San Joaquin County, is located one of the largest vineyards and wineries. Fine brandies are made in this district; also sherries, ports, and some excellent clarets.

Fresno County contains at this time some 16,000 acres of bearing vines and 15,000 acres of new plantings, the larger portion of which is grown for raisins. There are, however, a great many gallons of wine and brandy made in this county. The wines are mostly sweet, and of excellent quality. The raisin pack in 1889 was 626,595 boxes; the wine produced, 1,200,000 gallons.

The California "Wines and Vines," speaking of the Muscatel de Gordo Blanco, the true raisin grape, says: "The soil seems to impart a vigor to the vines that is unknown elsewhere in the world. The second crop is often very nearly equal to the first, and the third comes before the leaves fall off."

More than half the raisin grapes grown in California are produced in Fresno County. San Bernardino County is also principally devoted to the growing of raisin grapes. There are 9,562 acres of bearing and 4,125 acres of non-bearing vines, and the raisin pack in 1889 amounted to 375,000 boxes. Two wineries in San Bernardino County produced 279,000 gallons of wine in 1889. There were also shipped from this district 1,700 tons of table grapes. Los Angeles County has 18,120 acres of bearing vines. A new and mysterious disease attacked the vines of the southern portion of this district about 1885, and ruined more than one half of the acreage. Every effort has been made to discover the cause and remedy the evil. The most expert scientists have been consulted by the State Board of Viticulture in California, and the Department of Agriculture appointed an expert to investigate and report upon the matter. There were produced in Los Angeles County 25,820 tons, or 51,640,000 pounds, of grapes for wine, and 1,000 tons, or 2,000,000 pounds, of grapes for table purposes. The wines in this county are justly celebrated, and were the first shipped from California to the eastern markets. This county excels in its sherries, ports, and brandies. There were 20,000 boxes of raisins packed in 1889, the new disease having reduced the product about one half.

The product of Orange, a county lately formed from portions of Los Angeles County, is included in the above figures.

In San Diego County there is an acreage of 6,000 bearing and 7,500 non-bearing vines. Of the latter, 6,000 were just coming into bearing in 1889, and did not add much to the product. While this shows a fair increase in the growth of the industry during the last four years, the increase is accounted for by the fact that the new disease that was so injurious in Los Angeles did not affect San Diego County. It is in the El Cajon Valley of San Diego County that the most progress has been made in viticulture. There are 27,000 acres adapted to fruit growing and 3,000 acres of bearing raisin vineyards in El Cajon. The raisins from this valley are among the finest produced in California. The product of the El Cajon Valley in 1889 was 75,000 boxes; in the balance of San Diego County the pack was 75,000 boxes; in all, 150,000 boxes. Another successful branch of viticulture in this district is the shipment of table grapes to the eastern markets. Many of the elevated localities are so free from frost that grapes can be left on the vines until January.

A Large Grapevine.

As it has been noted in this bulletin that California has the largest vineyard in the world, it may be well to state that she has also the smallest. It is a vineyard consisting of a single vine, in Santa Barbara County. It was planted by a Mexican woman about sixty-eight years ago, and has a diameter one foot from the ground of twelve inches, its branches covering an area of 12,000 feet, and produces annually from 10,000 to 12,000 pounds of grapes of the Mission variety (many bunches weighing six or seven pounds), the crop being generally made into wine.

The old lady who planted this one-vine vineyard died in 1865 at the age of 107.

Viticulture, already a great industry in the Pacific division, promises to become still greater in the near future.

The census investigation of viticulture shows that outside of the regular districts already mentioned there are probably 45,000 acres of bearing and 15,000 acres of non-bearing vines, an aggregate of small vineyards from one fourth of an acre upward, grown to supply a home demand for this healthy and delicious fruit, and a like demand for wine. This class of vineyards is to be found in every State and Territory of the Union, producing, in 1889, 67,500 tons of table grapes, and 22,500 tons of wine grapes, or 1,875,000 gallons of wine. These small plantings are more or less experimental, and, when proved a success in a small way, will doubtless lead to larger enterprises. In localities where the industry has thrived in past years, and has been abandoned on account of mildew and black rot, now that the United States Government, through its Department of Agriculture, is so successfully experimenting in regard to the causes of the diseases and the remedies to be applied to save the vines, and the favorable results are being known, a new interest is being manifested, and no doubt, when another decade has passed, the grape industry will be again successful and greatly increased in many of the now comparatively small grape-growing sections.

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